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Skills trends for green jobs in the steel industry in India

Regional Office for Asia and the Pacific

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Foreword

According to the Government of India, the increase in the demand for steel will grow at a rate of more than 8 per cent with the prospect of an increase in direct manpower by 2020. At the same time environmental concerns linked to the steel sector have become a serious matter that needs to be addressed as a priority by the Indian steel industry. The industry is expected to release up to 450 million tonnes of carbon dioxide (CO_2) by 2020, along with an increase in the country's installed steel production capacity, from around 90 to 200 million tonnes (MT) by 2020. This will necessitate a low carbon growth strategy for intensive steel production and the adoption of an adequate skills programme to support new green jobs and the greening of existing jobs to match the evolving demand.

India's climate policies regarding industrial production are mentioned in the National Mission for Enhanced Energy Efficiency (NMEEE) under the National Action Plan on Climate Change (NAPCC) which aims at reducing the greenhouse gas (GHG) emissions intensity of gross domestic product (GDP) by 20–25 per cent from 2005 levels by 2020. Thus, there is a growing need to achieve a balance between increased steel production and limiting possible damage to the environment.

The report of the Working Group on the Steel industry for the Twelfth Five Year Plan (2012–17) states that there is a need to progressively replace the old and obsolete facilities with efficient environmentally friendly (green) technologies in order to achieve higher standards of productivity and to utilize any waste energy to reduce the impact on the environment. One critical challenge for India will be to address the skills demand for the growing direct and indirect labour force, to achieve robust economic growth while complying with both voluntary and legally binding environmental commitments. Emerging skills sets are already anticipated for the green jobs and greening of existing jobs that a transformation of steel production will bring. Consequently, there is a pressing need to improve sector understanding on existing skill gaps and shortages. As green technologies are progressively introduced, demand will increase to develop a responsive system for the delivery of skilled workers that match the changing needs of industry and in particular in energy intensive sectors.

In this context, the International Labour Organization (ILO) Regional Office for Asia and the Pacific, in collaboration with the Korea Research Institute for Vocational Education and Training (KRIVET), has conducted research on green jobs and decent work in the steel sector in India. The author of the report, Ramesh Suri, met with the officers of the ILO Decent Work Technical Support Team for South Asia and the ILO Country Office for India, the Steel Authority of India Ltd, Tata Steel Ltd, the related steel, environment and manpower officers from the Federation of Indian Chambers of Commerce and Industry (FICCI), PHD Chambers of Commerce and Industry and the Manpower Union to gather research on the topic. A four-day visit to the Tata Steel plant in Jamshedpur was organized to discuss environmental issues with the human resources and alternate fuel resources (AFR) officers and engineers as well as with the environment and vocational training institutes.

These discussions primarily focused on the adoption of green technologies at the plants and the anticipated skills and knowledge needs of engineers, skilled artisans and semi-skilled workforce who are recruited from various training institutes. There was a consensus that all possible efforts will be made by the institutes to build the required skills in the workforce, however they acknowledged that in some cases the basic requirements of the steel sector and the industry in general are not met. A thorough desk review of the complete system of skills development, evaluation, training and certification was conducted based on information available from web resources and from discussions with Ministry officials.

Under the umbrella of the ILO/Korea Partnership Programme, KRIVET conducted a study on the global green technologies available for the steel industry. The study identified four clusters of green technologies that will impact the productivity of steel companies, the skill map of the workforce and the conditions of work in the Indian steel industry by 2020.

The purpose of this report is therefore to review in a systematic manner the skills available and skills required for the introduction and deployment of different clusters of green technologies. To facilitate the gap analysis, the report also provides a general description of the concept of green jobs and greening of existing jobs, as applicable to the steel sector in India. It reviews the existing systems in place for bringing to the labour market the skilled labour force in demand by industry and proposes some specific recommendations on how to adapt such systems to evolving demands, in particular through a higher level of public-private collaboration.

This report must be considered in the context of the continuing efforts made by the ILO in reviewing the need for skills for green jobs and the development of sector-based analyzes that can advance this global research work on promoting decent work. It should be read together with the ILO report, *Skills for green jobs* (ILO, 2011), and its findings shared with the government and the social partners in India. It is envisioned that the report will help bring evidence and additional new information for a well-informed tripartite dialogue on the best approach for promoting access to skills for green jobs and the greening of existing jobs in the steel sector that can help create decent, productive work and improve the competitiveness of the sector. It is further hoped that this report will contribute to the facilitation and operationalization of an integrated approach to the implementation of labour policies and climate change strategies in India with the creation of decent, productive work, in particular in energy intensive sectors.

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Executive summary

In a context where steel capacity is expected to rise six times, the report estimates that the direct workforce in the steel sector in India will increase from the present 0.23 million to 0.95 million by 2020 while indirect manpower will increase from 0.45 million in 2008 to 2.6 million. It is anticipated that 25 per cent of these direct new jobs shall be green jobs requiring training in green technology-based skills in addition to the occupation-based skills. The details of the new skills profile required with the implementation of new environmentally sustainable technologies are detailed in the report.

Against this background, the study was undertaken to appreciate the qualitative and quantitative impacts of the incorporation of new green technologies on the manpower of the Indian steel sector. Indian steel sector capacity was 56.6 million of tonnes per annum (MTPA) in 2009. A Memorandum of Understanding (MOU) was signed to increase capacity from 56.6 MTPA in 2009 to 275 MTPA in the coming decade. This capacity increase shall come with modern, more automated and efficient green technologies. This study has considered three clusters of green technologies as listed below:

Cluster A consists of those green technologies, which help to improve the energy efficiency of steel plants.

Cluster B consists of the use of alternative fuels which help to improve efficiency, reduce costs and CO_2 emissions.

Cluster C consists of technologies which are still in the development stage awaiting commercialization.

In this study, we have examined the present representation of the manpower skills and knowledge in the Indian steel sector and have projected the anticipated changes desired with the introduction of green technologies. Our recommendations for changes in the skills and knowledge map of the Indian steel sector focus on direct manpower and indirect manpower.

Main conclusions regarding direct manpower: This study concludes that the direct specific manpower productivity measured as tonnes of crude steel per man per annum (tcs/m/a) in the Indian steel industry is expected to increase with the introduction of modern, more efficient and automated green technologies. Steel production in India will see a sizable increase in both productivity and volume growth, along with a reciprocal increase in the absolute direct manpower by 2020.

The global manpower productivity average in the steel industry is 600 tcs/m/a whereas for the Indian steel industry the average remains at just 144 tcs/m/a. In view of the introduction of modern, more efficient and automated green technologies and the volume growth planned, the manpower productivity is expected to rise to 275 tcs/m/a by 2020. Based on the present and projected productivity parameters along with the enhanced capacity of the Indian steel sector, direct manpower is expected to increase from the present 0.23 million to 0.95 million by 2020. It

is anticipated that at least 25 per cent of these new jobs shall be green jobs requiring training in technology-based skills in addition to the occupation-based skills.[1]

Concise recommendations are given to accelerate the enhancement of the prevalent training system in India. These include:

i. Training for the implementers of government programmes. It is vital that the groups implementing the designed systems are trained to understand and appreciate the systems developed to ensure proper implementation and returns.

ii. Skills development strategy. It is critical that the skills development strategy of the steel industry is incorporated into the Climate Change Action Plan of India, to ensure simultaneous training of the manpower to take up the challenge of operating the plants with the modern, more efficient and automated green technologies as envisaged in the plan.

iii. Capacity building for training needs assessments and modifying the curricula. A section for continual training needs assessment of the workforce is desirable to provide an extensive understanding on ways to conduct training needs assessments as well as for ways of adjusting the system. This would help address and incorporate the identified gaps into the curricula of the industrial training institutes, polytechnic and graduate colleges in a time bound period to ensure that trained manpower is aligned with industry requirements.

iv. National level programmes. Should be strategically re-engineered to ensure that the general jobseeker group has a higher basic education than primary level and the skilled workforce has at least a secondary level education. These are necessary to meet the requirements of the new technologies, as these are dependent more on knowledge and specific skills and less on unskilled and semi-skilled inputs.

v. Improving the contract management skills of the plant workforce. The contracting out of services for both maintenance and operations management is becoming the norm and now is a necessity in steel plants. In this regard, exclusive technologies are increasingly being co-opted and serviced by supplier companies both for spares and trouble-shooting. Therefore the topic contracts management should be added to all branches of the polytechnic and graduate schools along with a provision for short-term executive courses in contracts management for working professionals.

vi. Graduate and polytechnic based executive programmes for skilled workers and supervisors. The pilot graduate and diploma based programmes in the steel plants implemented by some leading plants in collaboration with the graduate and polytechnic institutes in India should be replicated in other steel plants. This could be done through a public-private partnership between the government institutes at vocational, polytechnic and graduate level and the training centres of the steel industry. The training centres based on the curricula of the government institutes provide the training and the students are then examined and given certification by the government institutes.

[1] This is the considered opinion from the discussions and internal assessments made during the study. No definite governmental or steel industry estimates could be identified.

1. **A future system** comprises of the recommendations made to prepare the system for the provision of skills for green technologies for future jobseekers in the steel sector:

   i. Recommended actions to be taken with the implementation of Cluster A technologies for energy efficiency. According to the pragmatic assessment undertaken during the study for the Cluster A technologies for energy efficiency, most of the technology-based skills are available within the plant. The training should be delivered formally within the plant and be supported with additional informal on-the-job training by trained and experienced skilled artisans and operators in the plant. Human resources staff must chart out and implement in-house up-skilling programmes.

   ii. Recommended actions to be taken with the implementation of Cluster B technologies of alternative fuel and raw materials. Training programmes should be organized to improve the AFR operational skills of the identified AFR group of managers, engineers and workers at Indian steel plants. In addition, specialized skills training should be imparted to drivers and helpers engaged in handling hazardous waste.

   iii. Recommended actions to be taken with the implementation of the Cluster C technologies involving progressive technologies. These technologies are not yet at the commercialization stage and the exact requirement of these needs based occupational trainings shall become clearer as the technology advances towards commercialization. However, it is anticipated that training needs covering new occupations will appear soon.

   The report recommends that the following actions should be taken to prepare for an adequate workforce for the implementation of Cluster C progressive technologies in India. This would enable them to appropriately adopt the technologies and get the best return on investment from them once fully commercialized:

   a. Formation of skills, knowledge and technology group. The report recommends the following steps to create a skills, knowledge and technology (SKT) group:

   Step 1. A task force is recommended to be established that would be composed of experts from the steel plants, the Ministry of Labour, the Ministry of Industry, the Ministry of Science and Technology with the Ministry of Science and Technology as the nodal point for implementation.

   Step 2. It is recommended that this task force should form two groups from the members of the Indian research and development centres:

   i. A skills and knowledge management group to track and keep the plants updated on the development of the skills and knowledge for adopting Cluster C progressive technologies in the plants. Pilot scale trial of these technologies would determine the commencement of work for this group.

   ii. A technology management group to track the global development of various Cluster C progressive technologies and identification of new emerging technologies, while simultaneously keeping the steel plants updated on the progress of such technologies through leaflets, seminars and workshops.

b. Transparency in the local research and development groups. It is recommended that a task force of the Ministry of Labour and Employment, Ministry of Human Resource and Development, Ministry of Commerce and Industry and the Ministry of Science and Technology officials should initiate proceedings with the steel industry for the required legislation, guidelines or directions to the local research and development groups to take proactive steps to share their knowledge on these Cluster C progressive technologies.

c. Continual upgrading of trainers' knowledge in the country. It is recommended that a task force of Ministry of Labour and Employment, Ministry of Human Resource and Development and the steel industry should begin proceedings to incorporate in their training systems additional sections for upgrading the new skills required for progressive Cluster C technologies, for the trainers in the industrial training institutes (ITIs), polytechnic and graduate colleges.

Main conclusions regarding indirect manpower: This report estimates that 32 man-hrs/tonne of steel handled of indirect manpower is required to produce one tonne of the final product (steel). Based on this evaluation, the indirect manpower is projected to increase from the present 0.45 million to 2.6 million by 2020 to sustain growth in the production of steel. The indirect manpower would require occupation-based skills training in handling, safety, crane operation and truck driving. These skills are at present imparted by private institutions and on the job in the unorganized sector in India. The authorities have to take measures and ensure that sufficient training facilities are available to this workforce to ensure protection of the new workforce and the avoidance of untrained manpower deployment.

The following steps should be undertaken to provide an enabling environment for the generation of properly trained indirect skilled/semi-skilled manpower of truck drivers, riggers and construction workers:[2]

a. Specific courses can be developed in vocational institutes to train the driver trainers to enable them to become small time entrepreneurs and start new motor training institutes.

b. Specific subsidized microfinance schemes should be offered by the banks to support the trained entrepreneurs in their endeavours.

c. The motor vehicle driving licensing system should be enhanced and made stricter to ensure safe and efficient driving skills.

d. The government and private training institutes can introduce a new multi-tasking construction workers course for the indirect manpower to handle steel.

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[2] Some steps are already in place in some states. These have to be comprehensibly taken to protect and simultaneously generate the indirect labour force required.

Abbreviations

AFR	alternate fuel resources
AICTE	All India Council for Technical Education
BAEST	best available environmentally sustainable technology
BAP	best available performance
BAT	best available technology
BAU	business as usual
BF	blast furnace
BOF	basic oxygen furnace
BPSL	Bhushan Power and Steel Limited
BSL	Bhushan Steel Limited
CAGR	compound annual growth rate
CCS	carbon capture and storage
CDQ	coke dry quenching
CEO	chief executive officer
CO_2	carbon dioxide
CO_2/tcs	carbon dioxide per tonne of crude steel
DRI	direct reduced iron
DRI – EF	direct reduced iron – electric furnace
EAF	electric arc furnace
EIF	electric induction furnace
EOF	electric oxygen furnace

ESL	Essar Steel Limited
FICCI	Federation of Indian Chambers of Commerce and Industry
GDP	gross domestic product
GHG	greenhouse gas
GJ/tcs	gegajoule per tonne of crude steel
HBI	hot briquetted iron
HEOs	heavy equipment operators
IIL	Ispat Industries Limited
IIM	Indian Institute of Metals
IIT	Indian Institute of Technology
ILO	International Labour Organization
IPT	inter-plant transfer
ITI	Industrial Training Institute
JSPL	Jindal Steel and Power Limited
kg/thm	kilogramme to therm
KRIVET	Korea Research Institute for Vocational Education and Training
LC	low carbon
MBF	mini blast furnace
MgO	magnesium oxide
MoEF	Ministry of Environment and Forests
MOU	Memorandum of Understanding
Mt	metric tonne
MT	million tonnes

MTPA	million tonne per annum
NAPCC	National Action Plan on Climate Change
NCS	National Competency Standards
Nm^3/tpi	normal cubic meter per tonne Pig Iron
NMDC	National Mineral Development Corporation
NMEEE	National Mission for Enhanced Energy Efficiency
OBS	occupation-based skills
OEM	original equipment manufacturer
OFT	oxy fuel technology
PCI	pulverized coal firing
PI	Pig Iron
R&D	research and development
RINL	Rashtriya Ispat Nigam Limited
SAIL	Steel Authority of India Limited
SCE	specific CO_2 emissions
SEC	specific energy consumption
SKT	skill, knowledge and technology
SRU	Sail Refractory Unit
t/m/a	tonnes per man per annum
TBS	technology-based skills
/tcs	per tonnes of crude steel
tcs/m/a	tonnes of crude steel per man per annum
TGT	top gas pressure recovery turbine
THF	twin hearth furnace

/thm	per tonnes of hot metal
TISCO	Tata Iron and Steel Works Limited
TNA	training needs assessment
/tpi	per tonnes Pig Iron
TSA	technical skills assessment
VTI	Vector Technology Institute
WHRS	Waste Heat Recovery Systems

1. Background information on the steel sector in India

The installed capacity of the Indian steel sector in 2009 was 56.6 MTPA. India has 11 integrated steel plants as well as many other small units. India is the fifth largest crude steel and the largest sponge iron producer in the world.[3] The per capita steel consumption in India is just 48 kg per annum (2008) as against the world average of 214 kg.

Table 1. MOUs signed by Indian States for investments in steel

State	No. of MOUs signed	Capacity (MTPA)
Total	222	275.70
Orissa	49	75.66
Jharkhand	65	104.23
Chhattisgarh	74	56.61
West Bengal	12	21.00
Other states	22	18.20

Source: Annual Report of Indian Steel Ministry, 2009–10.

Table 2. CO2 emissions of some of the countries (figures of 2007)

Rank	Country	Annual CO_2 emissions (in Mt)	Percentage of global total
	World	29 321 302	100
1	China	6 538 367	22.30
2	United States	5 838 381	19.91
3	India	1 612 362	5.50
4	Russia	1 537 357	5.24
5	Japan	1 254 543	4.28

Source: International Energy Agency, 2008.

This illustrates substantial residual steel demand in India. Global steel production reduced by 8 per cent from that of 2008 to 1220 MTPA in 2009, while Indian crude production grew at the compound annual growth rate (CAGR) of 8.6 per cent from 2005 till 2010. Thereafter in 2010,

[3] Ministry of Environment and Forests of the Government of India, 2010.

222 MOUs have been signed between different Indian States (table 1) and the Indian and global steel producers for a planned 276 MTPA increase in steel capacity by 2015–16 at an investment of US$229 billion. This may not be possible within the timeline specified, but it is expected to be in place by 2020. With this additional capacity, India is expected to become the second largest producer of crude steel. India is the currently the world's third largest greenhouse gas emitter, accounting for 5 per cent of global emissions as in table 2.

To remain profitable through the downturn in the 1990s, the Indian steel sector invested heavily in optimization of energy and fuel efficiency through the green technology route. With this, the specific emissions of GHGs in the Indian steel sector improved from 1994–95 till 2008.

The present emission intensity of the Indian steel sector is 2.4 Mt CO_2/tonnes of crude steel (CO_2/tcs).[4] By 2020, under the business as usual (BAU) scenario, the energy and fuel efficiency optimization efforts shall reduce the GHG emission intensity to 2.2 Mt CO_2/tcs. By 2020, under the low carbon (LC) scenario, with the induction of the best available technologies (BAT) like pulverized coal firing, top gas pressure recovery turbines, waste heat recovery of the high temperatures exhaust gases and continuous casting to recover heat from ingots, the emission intensity of the steel sector is projected to be reduced to 2.0Mt CO_2/tcs. The energy consumption in the Indian steel sector was reduced from 42 gega joule per tonne of crude steel (GJ/tcs) in 1990 to 27.3 GJ/tcs in 2008, which is still 40 per cent higher against the global best of 16.6 GJ/tcs. Technological improvements can help to cover this gap. With the use of alternative fuels like pulverized coal, natural gas and biomass charcoal in the planned installation of 275 MTPA capacities, for which MOUs have been signed, the savings on CO_2 emissions would be 345 MTPA (see table 5).

Table 3. GHG emissions from industry sector 2007

Industry sector	**Million tonnes CO_2 per annum**	**Percentage of total Industry emissions**
Iron and steel	117.32	28.4
Cement and other minerals	129.92	31.7
Other metals	5.42	1.3
Chemicals	33.50	8.1

Source for tables: Ministry of Environment and Forests, 2008.

[4] Associated Chambers of Commerce and Industry of India (ASSOCHAM) and Ernst & Young: *Report on climate change* (New Delhi, Centre for Science and Environment, 2010). Available at: http://www.cseindia.org/userfiles/39-56%20Steel(1).pdf [accessed 19 Nov. 2013].

Table 4. GHG emissions/removal by sinks in India in 2007

Sector	Million T of CO_2 per annum	Percentage of total emissions
Total	1 727	100
Energy Sector	1 100	63.67
Industry	412	23.89

Source for tables: Ministry of Environment and Forests, 2008.

Table 5. Potential for reduction of CO_2 by adopting various alternate fuel technologies for the 276 MTPA expansion planned in India till 2015–16

Green technology of Alternate fuels	Usage	Specific saving potential of CO_2	Potential of saving CO_2 emissions (MTPA)
Pulverized coal firing	Replace 160Kg- coke/t-pig iron	0.20t-CO_2/t-pig iron	55.2
Use of natural gas	100Nm^3/t-pig iron	0.25t-CO_2/t-pig iron	69.0
Use of biomass charcoal	210kg-charcoal/t-pig iron	0.8t-CO_2/t-pig iron	221.0

Source for tables: KRIVET, Ministry of Environment and Forests, 2008.

It can be safely assumed that the policies of the government would ensure that the planned capacity addition of 275 MTPA by 2015–16 would be by the use of BATs.

Table 6 demonstrates that the basic oxygen furnace (BOF) process dominates the steel production processes in India.

Table 6. Crude steel production by process route in India

Process	Percentage share		
	2004–05	2008–09	2009–10 Apr.–Dec.*
Basic oxygen furnace (BOF)	52	45	47
Electric arc furnace	18	24	26
Induction furnace	30	31	27
Total	100	100	100

* Provisional

Source: Ministry of Steel, Government of India, 2011.

By 2020, the creation of green jobs and the opportunity for the greening of existing jobs would surface in integrated steel plants. The best available environmentally sustainable technologies (BAEST) provide higher energy efficiency and lower fossil fuel consumption.

Green technologies such as alternative fuels, waste heat recovery at high, medium and low temperatures, improving combustion efficiency through process optimization and oxy fuel technology combined with carbon capture and storage would help to reduce the specific GHG emissions and control the absolute emissions (refer to Annexes II–IV for more information on the Indian steel sector). Table 7 illustrates this with the economy opening up; the share of private sector enterprises is progressively increasing.

Table 7. Crude steel production public/private sector distribution (in million tonnes)

Sector	2005–06	2006–07	2007–08	2008–09	2009–10 Apr.–Dec.*
Public sector	16.964	17.003	17.091	16.372	12.483
Private sector	29.496	33.814	36.766	42.065	33.292
Total production	46.460	50.817	53.857	58.437	45.775
Public sector percentage share	36.500	33.500	32.000	28.000	27.000

* Provisional

Source: Ministry of Steel, Government of India, 2011.

Table 8. Primary energy consumption associated with the BAT in steel production with the BAP globally

Process		**BF-BOF** ***GJ/tcs***	**Smelt reduction-BOF** ***GJ/tcs***	**Coal DRI-EAF** ***GJ/tcs***	**Gas DRI-EAF** ***GJ/tcs***
Material preparation	Sintering	2.1			
	Pelletizing		0.8	0.8	0.8
	Coking	1.0			
Iron making	Blast Furnace	11.8			
	Smelt Furnace		17.0		5.6
	DRI			12.6	9.5
	BOF	1.0	1.0		
Steel making	EAF			5.6	5.6
	Refining	0.4	0.4		
	Continuous casting	0.1	0.1	0.1	0.1
	Total	**16.4**	**19.3**	**19.0**	**15.9**

Source: Berkeley & Green Rating Project - 2009, Centre for Science and Environment, New Delhi, 2010.

2. Green technologies for the steel industry in the Indian context

According to the study conducted by KRIVET there is a large number of technologies currently available to reduce GHG emissions from the steel industry.[5] Broadly these have been grouped under three clusters in this study.

Cluster A covers the green technologies that improve energy efficiency

A variety of technological innovations are available internationally to reduce the energy required for operating an integrated steel plant. These technologies can be adopted while installing new capacity, during process optimization, major maintenance shutdowns and also while changing the old equipment once rendered useless. All the technologies that lead to energy savings are grouped together, and the major technologies are detailed below. Although efforts can also be made to reduce energy consumption from non-process activities such as lighting, motor efficiencies, air-conditioning and fuel in machinery including trucks and heavy mining equipment, these areas of improvements are not addressed since it does not fit within the scope of this study.

Cluster A1 Blast furnace operation optimization
Cluster A2 Waste heat recovery systems (WHRS) for high temperature exhaust gases
Top gas pressure recovery technology (TGT)
Cluster A3 Waste heat recovery systems for medium and low temperature gases
Cluster A4 Use of energy efficient and variable speed fans
Cluster A5 Waste heat recovery from ingots through continuous casting
Cluster A6 Waste heat recovery from high temperature coke
Cluster A7 Waste heat recovery from slag
Cluster A8 Replace old plants with high capacity energy efficient plants

Cluster B covers the green technologies for using of alternative fuels and raw materials

Coke is the normal steel furnace fuel but is very carbon intensive. However, there are other lower cost fuels like coal, natural gas, hydrogen, plastic, and hazardous high calorific value waste which along with process changes like pulverization and oxygen injection, can replace coke as the primary source of energy and which have been increasingly used by industry with success. These initiatives for use of alternative fuels can result in better heat transfer, reduced costs and GHG emissions. All these initiatives, including alternative raw materials from the waste of other industries, are covered below:

Cluster B1 Pulverized coal injection
Cluster B2 Use of natural gas
Cluster B3 Use of biomass charcoal
Cluster B4 Oxygen injection
Cluster B5 Use of hydrogen as a reducing agent
Cluster B6 Use of plastics to replace coke
Cluster B7 Recycling of top gas as fuel

[5] Korea Research Institute for Vocational Education & Training (KRIVET): *The implementation of green jobs activities* (Seoul, KRIVET, 2010), http://eng.krivet.re.kr/eu/ec/prg_euCDAVw.jsp?pgn=1&gk=&gv=&gn=M06-M060000009 [accessed 19 Nov. 2013].

Cluster B8 Use of alternative raw materials such as lime, iron, alumina, and silica rich industrial waste to replace raw materials and additives

As these technologies are relatively new and the processes by which they ensure a reduction in GHG gases and natural resources requires detailed explanation. The following points discuss how their use affects GHG emissions from a technology point of view:

i **Cluster B1 technology:** Under alternative fuels, the **pulverized coal injection (PCI)** along with coke as per the BAP provides for replacement of 160 kg-coke/t-pig iron by coal, out of a total of 499 kg-coke/tpi required for steel making. This is expected to save around 0.20 t-CO_2/t-pig iron out of the total 2 tonnes-CO_2/tpi produced.

ii **Cluster B2 technology: Use of natural gas** reduces 0.25 t-CO_2 /t-pig iron produced with the use of every 100 normal cubic meter per tonne Pig Iron (Nm^3/tpi).

iii **Cluster B3 technology: Use of biomass charcoal.** Another very effective alternative fuel is biomass-based charcoal, which being CO_2 neutral, can be used up to quantities which would save 0.8t-CO_2/t-pig iron.

iv **Cluster B4 to B7 technologies:** Other alternative fuel initiatives like partial oxygen injection, use of hydrogen, plastics, and recycling of top gas as fuel after removing CO_2 are other green technologies, which can be adopted based on their commercial viability.

v **Cluster B8 technology:** Use of alternative raw materials like lime, iron, alumina, silica rich industrial waste to replace raw materials and additives, raw material wastes to replace the basic raw materials for steel production are schemes to reduce their primary mining, handling and processing and thus reduce overall GHG emissions.

Table 9. Manpower and capacity estimates for the major integrated steel plants in India

Company	2008–09			2011–12		2019–20	
	Capacity MTPA	Manpower	Specific Manpower/TPA	Capacity MTPA	Manpower	Capacity MTPA	Manpower
SAIL	12.84	121 295	105.85	24.84	193 585	60.00	369 385
RINL	2.90	17 477	165.93	6.30	37 960	6.30	37 960
NMDC	Nil	-	-	Nil	-	3.00	15 000
TISCO	6.56	34 260	192.00	13.00	55 800	33.50	130 345
ESSAR	4.60	21 905	210.00	14.50	61 505	20.50	83 325
JSW	4.10	19 524	210.00	11.00	47 125	31.00	119 850
JSPL	1.20	5 714	210.00	10.50	42 915	26.50	101 100
ISPAT IND	3.00	18 072	166.00	5.00	30 120	17.00	90 120
Total	33.64	2 27 787	147.68	85.14	469 005	197.80	947 085

* SAIL Estimates are till 2011–12 only

Source: Ministry of Steel, Government of India, 2011.

Cluster C covers the progressive green technologies under development in the world to reduce GHG emissions

Technologies that are at various stages of research, development and commercialization that are likely to become commercially available in the coming decade are highlighted below.

Cluster C1 Nuclear captive power plants
Cluster C2 FINEX of POSCO
Cluster C3 Elimination of sintering process
Cluster C4 Coke dry quenching
Cluster C5 Sintered iron dry quenching
Cluster C6 Oxy fuel technology
Cluster C7 Carbon capture and storage

There are some other Cluster C technologies available such as the recovery of sensible heat from slag which are at very early stages of development and thus, have not been covered under this study. However, oxy fuel and carbon capture and storage (CCS) technologies require special mention as a lot of future plans for CO_2 emission reduction are based on the success of these technologies. These technologies are given below:

Cluster C6 and C7 technology (of main interest to this report): Oxy fuel and carbon capture and storage technology

Here, air in the system is replaced by pure oxygen. This in itself is expected to reduce energy consumption by 50 per cent. As oxygen is only 16 per cent of the air and is the main combustion element in use from the air during the process, the replacement of air by oxygen would result in lower volumes of combustion air (oxygen). It is envisaged that this oxy fuel technology could increase the capacities of the present furnaces and reduce the capital invested in new plants because of reduced specific combustion air (oxygen) volumes handled. Furthermore, with the use of oxygen, the exhaust gases shall be 90 per cent CO_2 and steam. This CO_2 can then be captured through condensation of steam, and then compressed, stored and traded under the carbon control and storage technology. For the success of CCS, successful use of oxy fuel technology shall be a precondition.

Main barriers related to the green technologies in the steel sector

Cluster A: Technologies for improving energy efficiency

It is estimated that Cluster A technologies can further reduce up to estimated 10 per cent of GHG emission reductions, as the steel companies in India have already made the best use of the energy efficient technologies in present plants during optimization, and the new plants are already highly energy efficient.[6] The implementation of these technologies becomes difficult owing to the barriers as given below:

a. Lack of knowledge about the new energy efficient equipment, spares and control systems to be inducted as a continual improvement programme; and

b. Competing investment strategies, where investments are made for reliability and new capacity rather than for energy efficiency.

Cluster B: Technologies for using alternate fuels and raw materials

It is estimated that Cluster B technologies can potentially reduce up to 40 per cent of the GHG emissions reductions. Although introduction of this group of technologies is still to take off in the steel sector in India there is certainly a very important opportunity to take advantage of such technologies. Barriers to their implementation include:

a. Lack of trained manpower at all levels to effectively identify, procure, and use the AFR in the steel plants;

b. Lack of knowledge of the managers, engineers and workers of the steel plants of the

[6] These figures are based on discussions with the steel industry and environmental experts.

matching availability of waste to the fuel or raw material to be replaced. These have to be gained from countries in Asia, Europe and North America using these technologies. Lack of knowledge of managers, engineers and workers about the use of technology within the steel plants;

c. Lack of understanding of the economic viability of the use of AFRs against the use of traditional fuel with additional investments in handling, storage, feeding and control systems;

d. Unreliability of supply both in terms of quantity and quality of the waste;

e. Legal limitations**,** since India lacks laws for disposal in steel and power plants;

f. Internal stakeholder apprehensions regarding steel plants like its use would adversely affect quality of steel and plant reliability and production; and

g. Lack of trained and knowledgeable government ministries, who could make and enforce laws that govern waste utilization in steel and power plants.

Cluster C: Progressive introduction of environmentally friendly technologies under development globally, to reduce GHG emissions

It is composed of technologies under development and trial runs, requiring the government and the industry to be updated on their development and if possible be a part of the development itself. This should be followed by the adoption of such technologies as they become technically or commercially viable. The barriers to their implementation are:

a. Lack of knowledge amongst the top management in the steel plants, decision-makers in the ministries regarding new technologies under development and their developmental progress;

b. Lack of transparency on behalf of the R&D group working on such technologies; and

c. Lack of trained workers to operate such technologies when they become commercially available.

National options for reducing carbon emissions in the steel sector in India

Quality of raw materials in India as a limitation to total absorption of all the best available technologies: The 222 MOUs signed for a steel capacity addition of 276 MTPA, with the BATs, would result in a very large potential for the generation of green jobs in the coming decade and the necessity of greening the present jobs, while the BATs are absorbed. However, the potential of adopting the BAT is limited on account of the quality of the raw materials to be found in India for steel production. There are some limits to which the Indian plants can reach the best available performance (BAP) and some concerns that the return on investment would be different under the Indian scenario.

Issue of quality of raw material to be found in India: The alumina content in iron ore fines used in sinter making all over the world is less than 1 per cent. In contrast, iron ore fines in India are as high as 3.0–5.5 per cent. The sinter quality produced from such alumina-rich ore fines is thus much poorer. The adverse effect of alumina on sinter strength productivity and its reduction degradation characteristics are well documented and conclusively established.[7] High alumina slag, which is highly viscous, requires a larger quantity of flux (10 per cent of Magnesium Oxide (MgO)) and relatively larger slag volumes resulting in an increase in coke consumption and a decrease in blast furnace productivity. According to one estimate, a decrease in alumina content in the sinter from 3.1 to 2.5 per cent will help to improve the reduction degradation characteristics by at least six points, lower blast furnace coke rate by 14 kg/thm and increase its productivity by about 30 per cent under Indian operating conditions.[8]

[7] V.G.K. Murty *et al.*: *Reduction of alumina in iron ore classifier fines and its influence on sinter properties* (New Delhi, Tata Search, 1994), pp. 7–13.
[8] C. Uday Kumar *et al.*: *Quality of sinter in the light of blast furnace performance* (New Delhi, Tata Search, 1995).

3. Mapping of green jobs in the steel sector in India

The present study, which focuses exclusively on the Indian steel sector must be considered in the light of the global research produced by an expert team from KRIVET on steel (2010–11). Based on this research the main environmentally sustainable technologies for the steel sector have been listed and studied on a global scenario including the technological, manpower and skill requirements for their implementation. Information is available in the report entitled *Implementation of Green Jobs Activities*. The main clusters of environmentally sustainable technologies developed in the KRIVET report and the information collected have been used to conduct the analysis of the present report as applicable to the Indian steel sector.

The present report first provides a general description of the concept of green jobs and the greening of existing jobs as applicable to the steel sector in India. On that basis, the skills required for each of the technologies in each environmentally sustainable (green) technological cluster are studied in more detail. To do so, the report has identified the teams of the existing skilled manpower in the steel plants which would be affected by the introduction of each of the technologies that are listed in the three clusters of environmentally sustainable (green) technologies. Further, based on the KRIVET study and other inputs, the skills that are required for the introduction and use of these green technologies are reviewed. From this data, the gaps in the skills available and required for implementation of the technologies of each cluster are methodically assessed. The required actions to fill up the identified gaps are discussed later in the report.

The trends in the direct and indirect manpower of the steel sector in India till 2020 are estimated taking into account the projected improvement in productivity (measured as tonnes of crude steel per man per annum (tcs/m/a)) and in the steel production capacity in India. Indirect manpower is studied to identify the manpower and skills needs before and after implementation of the green technologies. Actions required to address the gaps identified in the manpower and skills, are discussed later in the report, see table 13.

3.1 Green jobs and the greening of jobs

Since industrialization, there have been two categories of jobs: white- and blue-collar jobs for workers. With the efforts to reduce GHG emissions and improve environmental sustainability through the introduction of environmentally sustainable technologies, production processes and products, newly defined green jobs and workers have come into existence and are central to any effort to reduce GHG emissions and open up new jobs sectors. Additional skills learnt by white- and blue-collar workers, by adopting the green technologies and process results in the greening of their jobs. All new jobs directly created as a result of the greening initiative, and related to the production of green goods and services, and which are also decent jobs are designated as green jobs.

3.2 Mapping of green jobs, technology wise in the steel sector in India

The workforce that is directly affected by the introduction of the three clusters (A to C) of green technologies in the Indian steel sector is presented below into four main groups (teams), namely:

Team1. Input material procurement team

Team2. The plant production team
Team3. Product distribution team
Team4. The marketing and knowledge transfer team

The skills of other support teams like finance, costing, management, administrative, human resource, etc. are not considered by this report as they are not affected directly by the introduction of these three clusters of green technologies, or at least not in a significant manner. Consequently, these teams do not figure in the mapping exercise of this study.

The impact of the green technology initiatives on the skills of each of these four teams 1 to 4 forms the basis for the mapping exercise of green jobs in this report. The implementation of the three clusters of technologies in the steel sector for producing environmentally friendly steel requires a change in the composition and the skill set of the four teams. New skills and a trained workforce is required mainly for teams 1 and 2 while re-training of the existing skilled manpower is desirable in almost all the four teams 1 to 4 to ensure the successful introduction of all three clusters of green technologies in the steel sector. The broad effect on each of the teams 1 to 4 from the introduction of the A-C green technologies is described in table 10.

Table 10. Effect on each manpower deployment area by the adoption of the Clusters A to C of green technologies in the steel sector in India

Cluster details	Initiatives	Input material procurement area	The plant production area	Product distribution area	Market and knowledge transfer area
Cluster A	Technologies for improving energy efficiency	Yes	Yes	Minor	Minor
Cluster B	Technologies for using alternative fuels and raw materials	Yes	Yes	Minor	Minor
Cluster C	Use of the progressive green technologies under development in the world to reduce GHG emissions.	Yes	Yes	Yes	Yes

Source: Ministry of Steel, Government of India, 2011.

It must be appreciated that to sustain the energy and emission exercise of optimization in the old plants, the present workforce of 0.23 million shall need re-training with greener technology-based competencies. The green jobs mapping exercise consists of studying the impact of the three Clusters A to C of green technologies on the skills and the knowledge map of the selected four teams of workers within the steel plants.

Cluster A: Technologies for improving energy efficiency

The Cluster A technologies for energy efficiency improvement comprises of the commercialized technologies and those under the marketing roll out stage after becoming commercially viable.

Here, the area of knowledge transfer during their adoption, roll-out and development becomes important and requires a modified skill pattern in the workforce.

Without this modified skill pattern in the workforce, there may be delays in implementation and the gestation period for achieving the best available performance of the technology, which would increase till the skills are developed through hit and trial method on-the-job training. This development of the modified skill pattern in the workforce was discussed with stakeholders including the training sectional heads. The identified green jobs and their skill pattern improvement requirements for the adoption of Cluster A technologies were developed during this study and are enumerated in table 11.

Cluster B: Technologies for using alternative fuels and raw materials

The natural resources and fossil fuel used by the steel sector can be conserved through the use of Cluster B technologies, thereby reducing GHG emissions. Here, the effect on the skills mapping of the four identified teams of the steel sector were mapped. The Cluster B technological measures B1 to B8, through which fossil fuels and natural resources use can be reduced, are catalogued previously in the report. The percentage use of AFRs in the Indian steel sector compared to their use in developed countries is low. It shows a lack of initiative, both at the government level as well as the industry level for SKT transfer from the countries where AFR percentage usage is higher. The generation of green jobs and the greening of the present jobs identified for each of the measures, in each of the four identified teams 1 to 4 of the steel sector is reviewed in table 12.

Cluster C: Use of the progressive green technologies under development globally to reduce GHG emissions

One of the most appropriate and important progressive technologies which can help to attain the international targets of GHG emission reductions is CCS. It is understood that the Indian authorities at present are not considering the application of CCS. However, it may be adopted once it becomes commercially viable and internationally legally binding. Its use would require development and importation of technologies for CO_2 capturing, refining, transport, underground storage, and utilization. These technologies would require personnel with qualifications of masters degree or higher in chemical engineering, mechanical engineering, environmental engineering, civil engineering and geology. As this would be a new workforce demand, and is most likely to become a necessity in the near future, developing related subjects on these engineering lines in the engineering colleges would be desirable. As experience is gained by the application of CCS in other countries, the government through incentives and support can initiate application to the steel plants in India. This would be true for all the new technologies that are being developed and would be imported into India over a period of time. The known Cluster C progressive green technologies from C1 to C7, which are at different stages of development from R&D to commercial application, are listed in Section 2.1.

Table 11. Cluster A green technologies for improving energy efficiency: List of green and greening of jobs with use of Cluster A green technologies for improving energy efficiency and reducing GHG emissions

Sr.No.	**Energy efficiency improvement initiative**	**Green Jobs**				**Greening of jobs**			
		Input material procurement area	Knowledge transfer area for R&D and pre-commercialization on technologies	Plant production area	Product distribution area	Input material procurement area	Knowledge transfer area for R&D and pre-commercialization on technologies	Plant production area	Product distribution area
Cluster A green technologies for improving energy efficiency									
A1	Blast furnace process optimization	None	None	None as the same operations and maintenance (O and M) staff can operate this	None as the product has not changed	None as the input materials have not changed	The optimization process shall have to be understood by the staff	The optimization process shall have to be understood by the staff	None as the product has not changed
A2	Waste heat recovery systems for high temperature exhaust gases (WHRS) Top gas pressure recovery technology (TGT)	None	Sharing the business case in Indian scenario	None as the same O and M staff can operate this	None as the product has not changed	Stores and procurement staff to understand the new spares required.	This area is new, but the R&D people can take up the jobs in addition.	Process engineers, control room operators and electrical staff	None as the product has not changed
A3	Waste heat recovery systems for medium and low temperature gases	None	Sharing the business case in Indian scenario	None as the same O and M staff can operate this	None as the product has not changed	Stores and procurement staff to understand the new spares required.	This area is new, but the R&D people can take up the jobs in addition.	Process engineers, control room operators and electrical staff	None as the product has not changed
A4	Use of energy efficient and Variable speed fans	None	Sharing the business case in Indian scenario	None as the same O and M staff can operate this	None as the product has not changed	Stores and procurement staff to understand the new spares required.	This area is new, but the R&D people can take up the jobs in addition.	Process engineers, control room operators and electrical staff	None as the product has not changed
A5	Waste heat recovery from ingots through continuous	None	Sharing the business case in Indian scenario	The O and M staff operating the transfer area of casts and planners	None as the product has not changed	Stores and procurement staff to understa	This area is new, but the R&D people can take up the jobs in	Process engineers, control room operators and	None as the product has not changed

	casting					nd the new spares required.	addition.	maintenance staff	
A6	Waste heat recovery from high temperature coke through coke dry quenching (CDQ)	None	Required	The O and M staff operating the quenching system	None as the product has not changed	Stores and procurem ent staff to understa nd the new spares required.	This area is new, but the R&D people can take up the jobs in addition.	Process engineers, control room operators and maintenance staff	None as the product has not changed
A7	Waste heat recovery from Slag	None	Required	The O and M staff operating the recovery system	None as the product has not changed	Stores and procurem ent staff to understa nd the new spares required.	This area is new, but the R&D people can take up the jobs in addition.	Process engineers, control room operators and maintenance staff	None as the product has not changed
A8	Replace old plants with high capacity energy efficient plants	None	None	None as the same O and M staff can operate.	None as the product has not changed	None as the input materials have not changed	The new process has to be understood	The new process has to be understood by the staff	None as the product has not changed

Source: Ministry of Steel, Government of India, Government of India, 2011.

Table 12. Cluster B: Technologies for use of alternative fuels and raw materials: List of green and greening of jobs with use of Cluster B technologies for using alternative fuels and raw materials to reduce GHG emissions.

Sr.No.		Green Jobs				Greening of jobs			
	Alternate fuels - technologies	Input material procurement area	Knowledge transfer area for R &D and pre-commercialization technologies	Plant production area	Product distribution area	Input material procurement area	Knowledge transfer area for R &D and pre-commercialization technologies	Plant production area	Product distribution area
Cluster B: Technologies for use of alternative fuels and raw material:									
B1	Pulverized coal injection in blast furnace (PCI)	None	None	O and M staff for coal mills	None as the product has not changed	Stores and procurement staff to understand the new spares required.	R&D for trouble-shooting and reaching BAP	Process engineers, control room operators and maintenance staff	None as the product has not changed
B2.	Use of natural gas	Procurement and storage people for gas.	Sharing the business case in Indian scenario	The O and M staff operating the gas storage and use area.	None as the product has not changed	Stores and procurement staff to understand the new spares and safety requirements.	R&D for trouble-shooting and reaching BAP	Process engineers, control room operators and maintenance staff	None as the product has not changed
B3.	Biomass based charcoal	Procurement and storage people for charcoal	Sharing the business case in Indian scenario	The O and M staff operating the charcoal firing	None as the product has not changed	Stores and procurement staff	R&D for trouble-shooting and reaching BAP	Process engineers, control room operators and maintenance staff	None as the product has not changed
B4.	Oxygen injection	Procurement and storage people for oxygen	Sharing the business case in Indian scenario	The O and M staff operating the oxygen storage	None as the product has not changed	Stores and procurement staff	R&D for trouble-shooting	Process engineers, control room operators and maintenance staff	None as the product has not changed
B5	Hydrogen as reducing agent	Procurement and storage people for hydrogen	Sharing the business case in Indian scenario	The O and M staff operating the hydrogen storage	None as the product has not changed	Stores and procurement staff	R&D for trouble-shooting	Process engineers, control room operators and maintenance staff	None as the product has not changed
B6	Waste plastics	Procurement and storage people for	Sharing the business case in	The O and M staff	None as the product	Stores and procuremen	R&D for trouble-	Process engineers, control	None as the product

		plastics	Indian scenario	operating the plastic storage	has not changed	t staff	shooting	room operators and maintenance staff	has not changed
B7	Recycling of top gas as fuel for preheating	None	Sharing the business case in Indian scenario	None	None as the product has not changed	None	R&D for trouble-shooting	Process engineers, control room operators and maintenance staff	None as the product has not changed
B8	Use of alternative raw materials from waste	Procurement and storage people for plastics	Sharing the business case in Indian scenario	The O and M staff operating the plastic storage	None as the product has not changed	Stores and procurement staff	R&D for trouble-shooting	Process engineers, control room operators and maintenance staff	None as the product has not changed

Source: Ministry of Steel, Government of India, Government of India, 2011.

Table 13. Direct and indirect manpower projections for the integrated steel plants in India

Year	Capacity MTPA	Direct manpower	Indirect manpower[9]		
			Crane operators and HEO, riggers	Truck drivers	Total incl. handlers
2008–09	33.64	227 787	11 212	46 255	448 533
2011–12	85.14	469 005	28 380	117 067	1 135 200
2019–20	197.80	947 085	65 932	271 975	2 637 333

Source: Ministry of Steel, Government of India, 2011.

[9] Calculated at the labour productivity calculations, see Annex VII.

3.3 Direct and indirect manpower in the Indian steel sector

The specific manpower in the steel sector is identified by a ratio of crude steel produced per man per annum. The higher the tonnes of crude steel per man per annum (tcs/m/a), the lower the manpower required to make steel. The manpower used directly in the steel plant to make steel is direct manpower. The manpower used for other associated jobs for ensuring an incoming supply of materials and services, outgoing products right from the delivery from the plant till its use in construction and other associated jobs is indirect manpower which is identified by indirect man-hours spent per tonne of steel produced and used.

Direct manpower in the steel sector

With the implementation of automation and best available environmentally sustainable technologies through the optimization of the running units in the steel sector and the commissioning of the higher capacity more energy efficient modern steel plants in India, the direct labour productivity of the steel sector, measured by tcs/m/a has progressively improved.

The manpower strength of the Steel Authority of India Limited (SAIL), the largest public sector undertaking of steel in India, has reduced from 128,804 in March 2008 to 121,295 in March 2009 and 119,105 by 1 January 2010, whereas the capacity has remained almost stagnant. The labour productivity in many developed countries is 600 tcs/m/a. Against this the labour productivity in the public sector SAIL steel plants is 106 tcs/m/a, 166 tcs/m/a in Rashtriya Ispat Nigam Limited (RINL) and 210 tcs/m/a at the private sector Tata Steel plants. The mean labour productivity of the Indian steel sector in 2009–10 was 144 tcs/m/a. The new steel capacity addition will have better labour productivity.

Based on discussions with the authorities, unions and plant management for capacities added from 2011–12, the labour productivity is anticipated to be 166 tcs/m/a (the same as that of RINL) for the Indian public sector steel companies and 250 tcs/m/a for the Indian private sector steel companies. For the additional capacities planned up to 2020, it is projected to be 200 tcs/m/a for Indian public sector steel companies and 275 t/m/a for the Indian private sector steel companies. Based on these estimates, the total trained direct manpower required by the Indian steel sector would increase from the 0.23 million in 2008–09 to 0.47 million by 2012 and 0.95 million by 2020.

The workforce is expected to quadruple by 2020 whereas the steel capacity is expected to rise by six times. It is anticipated that 25 per cent of the jobs shall be green jobs. This new workforce shall require, within this decade, training both in the occupation-based skills and the technology-based skills.

Indirect manpower in the steel sector

The increase in capacity and the influx of the more energy efficient plants and the green technologies would not only increase the direct skilled manpower but would also multiply the indirect skilled workforce required for fostering the growth, arranging raw materials and distributing the steel. This increased indirect skilled manpower has to be closely watched and efforts have to be made to provide trained and skilled labour to meet the demand to ensure that the growth plans of the steel sector are crystallized without problems. The manifestation of the increase in the indirect manpower has to be taken into account and provided for in terms of the national skills upgradation programmes.

It must also be appreciated that steel is a low cost, high volume, high-density product, which requires a large workforce for production, but its indirect manpower requirements are also comparable. Indirect manpower is required in areas of mining, procurement and transportation of the raw materials, coke and additives, like coal, diesel, gas, steel grade limestone, stores and spares, and the marketing and distribution of the final product steel over long distances around the country and the world for export. The growth of the indirect jobs has to be taken into account while mapping the sector. These jobs also require trained manpower to ensure that the product is produced and then sold so as to ensure a return on investment. In the case of steel, occupation-based skills (OBS) are required for this indirect workforce, as the product, steel is not changed by the adoption of the BAESTs. Tracking the movement of raw materials, stores and spares and the product shows that, on an average, the indirect manpower over the life cycle of the steel production till its use is around 32 man-hours per tonne of steel produced.[10] The distribution skill-wise is given in Annex VII. The indirect manpower is expected to increase from 0.45 million in 2008 to 2.6 million in 2020 with a sixfold capacity increase of steel production in India.

Skills wise distribution of the indirect manpower distribution in the steel sector.

The distribution of the skilled labour required for satisfying the demand for indirect manpower for the steel sector is listed in table 11 which also includes an estimate of the numbers required for each skill from the year 2005 till the year 2020. These are rather large figures for this industry, for which an enabling environment has to be generated through proper incentives for private coaching institutes by the government, as most of these workers are trained either on the job or through private institutes. The various steps to be taken for meeting these requirements are discussed in detail in other sections in the later part of the report.

[10] This is based on discussions with the advisors, authorities, unions, procurement people and the plant. No detailed study has been done, but such a study should be made to assess the numbers and the skill needs of these categories of the very important set of indirect work force.

4. Skills for green jobs in the steel sector at the national level in India

Globally, there has been a focus on the development and transfer of existing and new green technologies. However, experience has shown that even though access to technology and capital are definitely required, they alone are not sufficient to provide a conducive environment for commercial returns for the industry. Knowledgeable management and a workforce with sufficient appreciation of the technology and the skills and knowledge requirements, are very important constituents for the technology to give the expected environmental benefits, economic returns and creation of jobs. A weak skilled workforce could result in rejection of the technology itself. To enable sustainable technology transfer, efforts have to be made well in advance to create the right skilled workforce to appropriately implement the same and ensure rightful returns both on environmental and commercial fronts.

A totally new group of people will have to be trained with new skills for the diffusion of the knowledge and skills related to the Cluster A and B technologies, which have been developed and commercialized, and for the Cluster C progressive technologies which are under development. A specific vocational, skills and knowledge management strategy shall need to be developed, supported by an international network to ensure proper diffusion of the technology. This is a totally new vocation which has to be developed with new skills and a proper network for information sharing, development of the business cases and reverse sharing of information to ensure research focuses on developing a commercially viable technology, and during development, calibrate it to suit the particular national requirements in India.

With the introduction of new environmentally sustainable technologies into the steel plants, technicians directly related to these technologies and other workforce would require technology-based skills (TBS) training. These trainings can be done in three ways, through in-house training, trainings conducted by the suppliers or trainings provided by an outsourced entity. These would be purely technical and operative trainings but since the technology is resulting in abatement of CO_2, both the jobs and the training should be considered as a training for green jobs and greening of present jobs.

Education and training requires time to be assimilated. It is widely accepted that human beings take around three years to absorb either knowledge or skills, so as to be in a position to replicate it and use it. This is why both properly developed courses in engineering (knowledge) and vocational training (skills) are for a minimum of three years. Both of them have to be assimilated slowly and then revisited repeatedly before they can be reproduced and used profitably. Short courses are only retraining courses to update the knowledge/skill. Skill and knowledge density of a particular technology is the highest where the technology is developed and commercialized. This is because, the workforce, both knowledge (engineers) and skill (technicians) based, have had time to assimilate and reproduce the same, during the development of the technology. The diffusion of this across the globe where the technology is rolled out is a difficult process. The technology can be rolled out very fast through capital and reproduction efficiency of the manufacturing facilities available. But the diffusion of skills and knowledge lags far behind, since it needs the human capital as a medium for its transfusion. Human capital requires time to assimilate and reproduce profitably.

A new vocation of global SKT management should be developed to ensure that the diffusion of both knowledge and skills takes place simultaneously. During the development of the technology, the international network for information and skill transfer should be made a continuous process. This would benefit the industry greatly. This is not only for the green technologies but also for all technologies, which are related to industry. Work on transparency and international payouts for this continual diffusion of global SKT management for protecting the intellectual property rights has to be done to take this initiative forward.

In India, the government and industry are well aware of the training requirements for new technology-based skills with the advent of new green technologies into steel plants and other industries. Care is being taken to provide better base level education for the new workforce, high school and vocational schools – industrial training institutes and then specific technology-based trainings. The government is also updating its policies to incorporate the provision of training and basic education.

The change of technology to Cluster A and B technologies for improving energy efficiency and using alternative fuels and raw materials is not a total shift from the present technology available within the steel plants. As and when the Cluster C progressive green technologies are made commercially viable and introduced into the steel plants, there shall be a major shift in the requirements of new technology-based skills for these green jobs. It is expected that most of the Cluster C progressive technologies should be a commercially viable solution by 2020, which necessitates a plan to prepare for transferring these green job skills within this decade. For other initiatives under Cluster A and B technologies, the changes are equipment oriented and others require modification of the present process for which, the skills are normally identified internally by the companies and upgraded through their own human resource initiatives with internal or outside faculties. The details of identification of skills and training for greening of the steel industry with use of Clusters A, B and C technologies are given in tables 14, 15 and 16 respectively.

In the steel sector, the efforts made to reduce energy consumption, improve productivity and lower operational and maintenance costs and the installation of high capacity plants with greater automation helps to improve labour productivity in steel sector. The labour productivity for the Indian steel sector is expected to reach an average of 250 tonnes of crude steel per man per annum by 2020 from 144 t/m/a in 2009–10, but the absolute manpower required would increase on account of higher production capacity.

It must be accepted that with greater complexity in operations at high capacity plants, the skills and education required would also require a change. Better skills and higher education would become the norm. The unskilled section would gradually become redundant. With exclusive outsourced technology being provided by the machinery suppliers, it has become very important to factor in the requirement of annual maintenance contracts for these exclusive technologies being adopted. Under the annual maintenance contracts, the direct occupation-based skills requirement in the plant reduces mostly to identification and appreciation of the faults, and the skills to administer these contracts increases. This is because the actual rectification is being done by the supplier's manpower.

These appreciation and contract administration skills are totally new occupation-based skills for the personnel at the steel plant, which needs upgrading and honing to ensure proper contract administration and equipment efficiency.

With the upgrading of the technology and automation and outsourcing of the specialized maintenance, the education levels of the workforce would undoubtedly require a vital change. Earlier, the unskilled workforce requirement was large and thus even uneducated and pre-primary educated workers could find work. But now, with automation, outsourcing of maintenance for specialized technology and equipment which comes with the high capacity plants, the basic education level of the workforce would need to be upgraded, as the uneducated and pre-primary group is being increasingly sidelined. The free education provided till primary level school should now be extended to secondary level schools and the eligibility level for vocational trainings should be also modified from secondary level education. Making primary education compulsory would help the job market in reducing the gap.

The programmes at the national level would have to provide the support to the steel sector to meet the skills, knowledge and technology levels so as to take the best advantage of the initiatives already taken with Cluster A and B green technologies. This ought to be followed by making preparations to keep the authorities and the sector updated on the developments on the Cluster C new green technologies (see table 15).

Table 14. Cluster B: Technologies for using alternative fuels and raw materials: Identification of skills and training for greening of the steel industry with use of Cluster B technologies to reduce GHG emissions

Sr. No.	New green technology	Additional skills required	Type of job identified	
			Green job / training status	Greener job / training status
Cluster B: Technologies for using of alternate fuels and raw materials:				
B1	Pulverized coal injection in blast furnace	Skills to O and M coal mills and skills to understand the process change by the CCR operators and the process engineers	√/Internal available	√/Internal available
B2.	Use of natural gas	Skills to O and M natural gas storage and skills to understand the process change by the CCR operators and the process engineers	√/Internal available	√/Internal available
B3.	Biomass-based charcoal	Skills to understand the process change by the CCR operators and the process engineers	√/Internal available	√/Internal available
B4.	Oxygen injection	Skills to O and M oxygen storage and skills to understand the process change by the CCR operators and the Process engineers	√ /through supplier	√/through supplier
B5	Hydrogen as reducing agent	Skills to O and M hydrogen storage and skills to understand the process change by the CCR operators and the process engineers	√ /through supplier or R&D	√/through supplier or R&D
B6	Waste plastics	Skills for the pre-processing of plastics and then O and M of the plastic storage and skills to understand the process change by the CCR operators and the process engineers	√/√	√/Internal available
B7	Recycling of top gas as fuel for preheating	Skills to understand the process change by the CCR operators and the process engineers	√ /through supplier or R&D	√/through supplier or R&D
B8	Use of alternative raw materials from waste	Skills for the pre-processing of alternative raw materials and then O and M of the AR storage and skills to understand the process change by the CCR operators and the process Engineers	√/Through other countries	√/Through other countries

Source: Ministry of Steel, Government of India, 2011.

Table 15. Cluster C progressive green technologies: Identification of skills and training for greening of the steel industry with Cluster C progressive green technologies

Sr. No.	New green technology	Additional skills required	Type of job identified	
			Green job / training status	Greener job / training status
C1	Nuclear captive power plants	Additional skills for O and M of the power plants	√/NEW	X/X
C2	FINEX process of POSCO	Additional skills for O and M of the power plants	√/NEW	√/internally available
C3	Elimination of sintering process	Additional skills for O and M of the sinter free process of iron making	√/NEW	√/internally available
C4	Coke dry quenching	Additional skills for O and M of the coke dry quenching plant	√/NEW	X/X
C5	Sintered iron dry quenching	Additional skills for O and M of the WHRS plant for sintered metal	√/NEW	X/X
		Additional skills to be imparted to the CCR operators	X/X	√/NEW
		Additional skills to transport, store, and take care of the stored CO_2 over the future would be totally new green jobs skills, as this is a new technology.	√/NEW	X/X
		Additional skills for geologist are to be developed to understand the geology of sealing the gas in the deep drill holes, so that it does not leak back	√/NEW	X/X

Source: Ministry of Steel, Government of India, 2011.

5. Skills related programmes at the national level in the Indian steel sector

The skills for the new jobs which shall be created in the steel sector in India with the dovetailing of the Cluster A, B and C green technologies shall be directly related to these technologies themselves. The best resource bundle, which can provide training for developing the skills to operate and maintain these plants with the new technologies, would be the following:

1. **The supplier** of the technology should be engaged while ordering to provide both the theoretical and the practical hands on training for operation and maintenance of the equipment and processes supplied.
2. **The plants in the other countries** where these technologies are already in use should be associated to provide the on-the-job training in their facilities to a set of people from these plants in India, so that these sets of technicians can go there and work with their counter-parts for three to six months. Using a train the trainer approach could be adopted, where the first set of people should become trainers on their return and then provide a formal and structured training to others at the plant.
3. **The curricula of the graduate**, polytechnics and the vocational training institutes have to be updated continuously so that they are in line with the requirements of the industry and the new technology.

Against each of the Cluster A, B and C green technologies identified there is a need for a set of technology-based skills to be provided to the workers in the field and even during the construction and commissioning. There are more than 4,650 vocational training institutes in India, known as industrial training institutes (ITI), providing occupational-based training in the following areas:

1. Craftsmen training scheme (CTS);
2. Apprenticeship training scheme (ATS);
3. Craft instructors training scheme (CITS);
4. Advanced vocational training scheme (AVTS);
5. Supervisory/foremen training scheme;
6. Staff training and research programme;
7. Instructional media development programme; and
8. Women’s training scheme.

It must be appreciated that there are very few institutes that provide technology-based training in skills for green technologies. There is no dedicated policy highlighting the need of specific technology-based training. However, both the Bureau of Energy Efficiency and the National Enhanced Energy Efficiency Mission under the National Action Plan on Climate Change have specified the training requirements for capacity building in the energy sector. It is desirable that the present training infrastructure available with the steel industry be upgraded to provide the following three pronged trainings:

1. A year-long occupational-based training and the technology-based trainings for skilled and semi-skilled manpower, including engineers and technicians to operate and maintain the new equipment through the incorporation of the Cluster A, B and C green technologies. These would be the pure green job applicants for the steel sector in India;
2. A short term re-training for the present and the normal skilled and semi-skilled manpower, including the engineers and technicians, whose knowledge needs upgrading with the technology-based training to appreciate the induction of the green equipment and the greening of jobs; and
3. A technology-based training for the trainers of the training institutes, to enable them to develop tailored training capsules and competency standards for the required technology-based training to the new job applicants on the Cluster A, B and C technologies.

These institutes and others shall have to organize a number of technology-based training programmes to introduce the new technologies. Some are enumerated below:

a. **Academic programmes**: National level academic programmes that award B.Tech, M.Tech, M.Sc. and Ph.D. degrees in association with reputable regional engineering colleges and Indian institutes of technologies;

b. **Vocational programmes:** Vocational programmes may have to be upgraded to Diploma level;

c. **Specialized programmes:** Begin several specialized short-term technology-based programmes targeting top personnel from the steel industry like the entrepreneurs, executives, technicians and supervisors, etc.; and

d. **On-site demonstrations**: Institutes should organize on-site demonstration programmes for technology-based developments to raise awareness about the new and clean technologies as well as to help the workers adapt to the new technologies.

The details of the government organizations for training and development are given in the Annexes. This mirrors the complexity of the responsibilities of the various ministries. It illustrates that for making any changes; the complex structure requires multi-ministerial coordination to ensure that all the technologies and skills are taken care of at all the three important levels including:

1. **Basic education** – Has to be upgraded from the illiterate to primary and from primary to secondary school. The illiterate workforce is slowly becoming redundant and re-training is an option for the present workforce and upgradation of the basic education level from being illiterate to primary level has become a necessity.
2. **Graduate and polytechnic engineering** – The present courses are to be upgraded for the new Cluster C progressive green technologies to understand and appreciate their intricacies, e.g. alternate fuels, oxy fuel, carbon capture and storage, elimination of sintering process, and waste heat recovery from high temperatures to very low temperatures of below 100 degrees Celsius. Contracts management has become important for the engineers, as annual maintenance contracts for exclusive technologies are becoming the norm in the industry. It is imperative that contracts management should form a part of the graduate engineering curricula.

3. **Industrial training institutes** – It is necessary to keep close contact with industries in the vicinity, to avail jobs from the vicinity for jobseekers. A system of upgradation of the curricula of these institutes should be in place, which is based on the continual technical skills assessment (TSA) of the industries in and around the institutes. It is important that the slots of continual TSA are identified and filled in the institutes, and specific trainings are provided to these people conducting TSA to ensure effectiveness and upgrading of the curricula.

The government, industry and the workers unions realize that there is a shortfall of trained manpower for the steel industry. All are making efforts to fill in the skills vacuum in the available workforce. It is also felt that with the volume of growth planned in the coming decade, this shortfall will only rise.

In a written reply to the Parliament, Mr. A Sai Prathap, Minister of State in the Ministry of Steel said that the Indian Institute of Metals (IIM), Kolkata conducted a study on technical manpower in the steel industry with an aim to assess the requirement of trained technical manpower to meet the growing need of iron and steel sector. The report was submitted by IIM, Kolkata to the Ministry of Steel in March 2008. In this report, no shortage of occupational-based trainings through industrial training institutes had been envisaged. However, the report has projected a shortage of technical manpower in disciplines like metallurgy and ceramic engineering. Similarly, some shortages have been envisaged in diploma holders for metallurgy. In a written reply to the Lok Sabha on 11 November, 2010, Mr. A Sai Prathap said that the Ministry of Steel has initiated several steps to meet the requirements of technical manpower which inter-alia includes:

1. The Department of Education and the All India Council for Technical Education (AICTE) have been requested to address the problems related to increasing number of seats in existing colleges or introducing metallurgy in private institutes.
2. Chief executive officers (CEOs) of steel companies and associations have been requested to find ways and means to attract metallurgical and ceramics engineers by giving attractive packages and improving working conditions of engineers.
3. The Ministry of Steel has created a steel technology centre at the industrial training institute (IIT), Kharagpur to promote higher study and research in the field of iron and steel making and to increase the numbers of trained manpower to sustain the growth and development of the steel industry.
4. The Ministry of Steel has created a Chair Professor and scholarships for five undergraduate students in several institutes to address the problem of shortage of faculties in these institutes and also to attract students towards studying metallurgy.

Further H.M. Nerurkar, the Chief Operating Officer of Tata Steel at a seminar of Steel Rise in Jamshedpur confirmed the shortfall envisaged by the industry on trained manpower and stated;

> "We would need more skilled manpower (read engineers) if the industry has to prosper. Today, premier institutes do not teach iron and steel production and youngsters are not interested in the subject. Therefore, more engineers need to be trained to meet up the

> growing market demands."[11]

At the World Economic Forum in 2012 the matter of the shortage of employable skilled manpower in India was discussed. Mr. Sunil Bharti, Chairman, Bharti Group, said,

> "Even as India has a large youth base, most of the industries are facing a shortage of skilled force. The biggest problem that most are facing is lack of employability. They (the employees) are not skilled and trained enough to suit the needs of the specific industries. […] The government must take the initiative to add more vocational courses. That'll solve the issue of unemployment and our economic growth will become inclusive."

This clearly shows that there is no dearth of manpower, but the right manpower, with proper skills and knowledge is missing.

As the government is still to take action, the industry cannot wait. The industry in general and several companies that have the ability to do so have set up their own vocational training institutions to address their respective needs. Tata Steel is one such company in India having developed its own vocational and training programme. In this regard, the case study on skills for green jobs from the Tata Company in India can be found in Annex I of this report.

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[11] The Telegraph*:* "Steelrise focus on manpower crunch – 50 global giants, 400 delegates take part in meet", 28 Feb. 2008, http://www.telegraphindia.com/1080228/jsp/jharkhand/story_8958581.jsp [accessed 19 November 2013].

6. Recommendations and way forward

6.1 Background

The Indian government views the reduction of GHG emissions from the steel industry as a high priority for the next decade. The industry has major plans for adding another 275 million tonnes per annum of steel capacity in the next decade to the existing 56.6 million tonnes per annum. This will be achieved by the introduction of modern, more automated and efficient environmentally sustainable technologies. With this being planned and the adoption of Cluster A and B technologies in their present traditional plants, the Indian steel industry is expected to make a huge reduction to their present GHG emissions. In this report, we have deliberated on the present scenario of the manpower skills map for the Indian steel sector and the system in place today to provide the skills to the jobseekers in the steel sector. Other than this, we have also projected the anticipated change in the skill map of the manpower for the Indian steel sector once the Clusters A to C of the environmentally sustainable technologies are introduced into the sector progressively and reflected on the preparedness of the present training system to provide these skills in the near future. Based on the study, recommendations have been made of potential changes for the system. Our recommendations have been made under two separate heads, direct manpower and indirect manpower.

Direct manpower in the Indian steel sector

This study concludes that the direct manpower productivity in tonnes of crude steel per man per annum (tcs/m/a) is expected to increase with the introduction of modern, more automated and efficient green technologies. The global average of manpower productivity in the steel industry is 600 tcs/m/a. The Indian steel industry average is just 144 tcs/m/a. In view of the introduction of modern, more efficient and automated green technologies and the volume growth as planned, the manpower productivity is expected to rise to 275 tcs/m/a by 2020. Based on the present and projected productivity parameters and the enhanced capacity of the Indian steel sector, direct manpower is expected to increase from the present 0.23 million to 0.95 million by 2020. It is anticipated that at least 25 per cent of these new jobs shall be green jobs requiring training in technology-based skills, in addition to the occupation-based skills. The details of the new skill profiles desired with the implementation of the Clusters A to C of green technologies have been detailed in the previous sections. Subsequent sub-sections discuss the recommended initiatives for upgrading the systems, to be undertaken to train the new staff and re-train the old staff to meet the new skill profiles in the coming decade.

Indirect manpower in the Indian steel sector

The study indicates that the indirect manpower required for the Indian Steel sector in the coming decade, is expected to increase production more than sixfold, as well as increase the distribution and consumption of steel. For the indirect manpower, the skills profile of this group would not change, but the absolute numbers required would increase from around 0.45 million in 2008 to 2.6 million by 2020. In the sub-sections on indirect manpower, the recommended initiatives to be undertaken are provided to ensure training for additional indirect manpower to ensure proper and safe use of the additional steel production.

6.2 Direct manpower

Direct manpower – present systems

i. Training for the implementers of the governmental programmes. The systems designed for skills development and evaluation, training and certification have been studied and it has been established that they are quiet effective. However, it is observed that there is an unambiguous gap between the skills required by the industry and those of the skilled jobseekers available. This is reinforced by the fact that the Indian steel sector is organizing secondary training for the skilled artisans and engineers, before putting them on the job, to bring their skills quality up to the required standard required by the sector. During the study, it was observed that this gap is due to the implementation of the excellent systems planned. It was apparent that the groups implementing the designed systems need a further training for understanding and appreciating the systems developed and for implementation. It is recommended that the following steps should be taken to fix the gaps in the implementation:

> **Step 1.** It is recommended that the group to be assigned the task of implementing these systems be clearly identified and be composed of people from various levels and departments.
>
> **Step 2.** It is recommended that the identified group be sub-divided into various sub-groups to deal with each hierarchical stage of the system across the country.
>
> **Step 3.** It is recommended that a well-defined training programme be designed for each identified hierarchical group, which is to implement these systems.
>
> **Step 4.** It is recommended that the interaction between industry and the training group should be emphasized, and systems direction should be modified to ensure that these are regular and fruitful. A time bound programme would help to upgrade and modify the curriculum to include the areas required by the industry post discussion.

These recommended steps would enable the implementing groups to get properly trained and become familiar with the system. Consequently, the system would be able to produce the right quality of skilled jobseekers for the industry.

ii. Skill development strategy for the steel sector to be part of the Climate Change Action Plan of the Indian Government. The study has noted that the government programmes do not provide opportunities for the skill development plans for the groups implementing the plans. The Climate Change Action Plan for the Indian steel sector requires the provision of a skill development programme for this industrial sector. It is critical to integrate a skill development strategy into the Climate Change Action Plan and other programmes. The following recommendations are proposed to meet this challenge:

a. A national skills expert should be a member of the team/committee formulating the Action Plan.
b. This expert shall examine the skills upgradation needed for implementing each of the initiatives. He shall formulate a plan to provide such skills to the present workforce and also ensure that the trained manpower is made available especially for sector where the skills required are totally new.
c. These recommendations should form a part of the Action Plan.

iii. Continual upgrading of the programmes through proper training on conducting training needs assessments (TNAs) and modifying the curricula. The study reveals that the ministerial and the Vector Technology Institute (VTI) administrators, industry, students and the community are aware of the wide gap between the skills of the VTI, polytechnic and graduate school trained jobseekers and those required by the industry. Although some systems are already in place for this, they are required to be more formalized and recognized.

The study indicates that the skills required for doing the TNA, which is the base on which the gap is assessed and closed, requires further honing. The implementing group cannot learn these skills, on the job, since these are very new initiatives and there are no people on the job to impart the hands on training. The polytechnic schools and the graduate schools under the Ministry of Human Resource and Development lack adequate trainings for conducting TNAs and continual upgrading as per the National Competency Standards (NCS) and the required curricula to close the gaps observed.

The country's skill training setup is unable to periodically upgrade the training instruments such as the NCS and curricula to meet the changing requirements of the industry, including the steel sector, as desired in the system.

It is recommended that the implementing groups should be identified and provided with detailed training on conducting TNAs to ensure the incorporation of gaps observed during the TNA into the curricula to fix the observed gaps in a timely manner.

iv. Workplace training for students at training centres /polytechnics. The study indicates that in the BAU scenario there is a high percentage of unskilled workforce requirements. With this, even uneducated and primary educated workers can find work. With the introduction of modern, more efficient and automated Clusters A, B and C green technologies into the Indian steel sector, the basic education level of the workforce would need to be upgraded in order to operate and maintain these plants. The study shows that the unskilled and uneducated workers are being increasingly sidelined and the lack of education makes them unfit for re-training and relocation. Strategically, efforts need to be made to ensure a higher basic education up to the primary level for the new general workforce, whereas for the skilled workforce, up to the secondary level education. For this, some basic changes are desirable in the national level programmes for the protection of the present as well as the future unskilled workforce of the industry.

It is recommended that the programmes at the national level be re-engineered to provide for:

1. Basic education and communication skills for the uneducated section of the workforce in association with the management of the Indian steel sector.
2. Specific skills retraining to be provided to the unskilled section of the workforce to secure their future employability.
3. Better education and communication skills should be imparted to the jobseekers by enforcing the following actions:
    a. The required legislation should be approved to make basic education of up to primary level compulsory and free, with English as a mandatory subject for enabling easier absorption of such technologies.
    b. The curriculum of the vocational training institutes both private and government needs upgrading to include communication as an additional subject for all vocations.

c. The required legislation needs to be approved for upgrading to the secondary level as the minimum entry level of education requirement for vocational training institutes.

v. Improving the contracts management skills in the plant workforce. The study shows that with the introduction of Cluster A to C green technologies and the installation of new plants with modern, more efficient and automated environmentally sustainable technologies, there shall be an influx of exclusive technologies in the plants. This shall require annual maintenance contracts with the suppliers and enforcement by the engineers and managers of the plant. These skills in contracts management should be imparted to the present workforce as well as to the new jobseekers at the level of managers and engineers, to ensure proper enforcement of the annual maintenance contracts. It is recommended that the given road map should be followed for imparting contracts management skills.

It is recommended that the curriculum of the polytechnics and graduate schools be upgraded as follows:

a. The subject of contracts management should be made a common and compulsory subject for all branches of the polytechnic and graduate schools.
b. Trained part-time or full time contracts management trainers should be inducted to provide the training to the students in the graduate and polytechnics schools.
c. Sufficient short-term executive programmes on contracts management should be introduced for the working professionals to offer them an opportunity to get trained in contracts management skills.

vi. Graduate and polytechnic based programmes for skilled workers and supervisors.

It is recommended that the graduate and polytechnic based programmes being run by the leading steel plants in India (along the lines of Holcim Cement in Indonesia) should be replicated in all the graduate and polytechnic institutes. The last semester should be used for hands-on training at the plant as per student's choice, so that they are ready for taking up responsibility as soon as their certification is complete.

It is recommended that the plants select the students who would take on the job training, so that there is a clear possibility for their absorption on completion of certification.

It is recommended that a public-private partnership between the government and private institutes at vocational, polytechnic and graduate level as well as with the Indian steel producers should be organized along the lines of Holcim Cements in Indonesia.[12] Briefly, Holcim Indonesia have their own academy which runs the programmes in association with the government training institutes to provide technology and occupation-based skill training to the technicians and graduate engineers. In this academy the government bodies associated with this venture, give the certification to the students. It is recommended that the following steps be taken to introduce such an initiative:

Step 1. The Ministry of Education should issue directions to the polytechnic schools to develop collaborations with their nearest steel plants for undertaking the diploma based programmes. The support from the plants should be ensured through a directive from the Ministry of Industry to the steel plants. The training institutes being operated by the

[12] Details are in the Indonesian manpower report on cement and are available on request from Holcim Indonesia and Holcim India.

government and private steel plants should be made the nodal points for this implementation.

Step 2. The Ministry of Education should send out directions to the graduate schools to develop collaborations with their nearest steel plants for undertaking trainings for engineers graduating from their institutes. The support from the plants should be ensured through a directive from the Ministry of Industry to the steel plants. The training institutes being operated by the government and private steel plants should be made the nodal points for this implementation.

6.3 Direct manpower – future systems

Recommended actions to be taken for the implementation of the Cluster A technologies for energy efficiency. It is an accepted norm that these technologies can be adopted while installing new capacity and also while changing the old equipment or its spares when they have served their normal life. The study indicates that this is not being done extensively because of:

a. Lack of knowledge in managers and maintenance staff about new energy efficient equipment, spares and control systems to be inducted as a continual improvement programme; and
b. Competing investment strategies, where investments are made for reliability and new capacity rather than for energy efficiency.

It is recommended that every Indian steel plant should have a plan and a set-up, under the human resource department, to provide extensive exposure to the development of energy efficient technologies, equipment with their valuations and economics, to the engineering, process, laboratory and operating staff of the steel plants. This would help them to bring in these technologies at the time of installation of new energy efficient plants as well as during the maintenance of the equipment.

Recommended actions to be taken with the implementation of the Cluster B technologies of alternative fuel and raw materials. The study indicates that internationally these technologies are relatively new for the steel plants. Some steel plants in India have implemented many of the Cluster B green technologies in their plants, but the percentage use of AFR in the Indian steel sector as compared to its use in other developed countries is low. It follows through that there is a need both at the level of the authorities and industry for SKT transfers from the countries where AFR percentage usage is high and from the Indian plants using Cluster B green technologies. For this, the following plan has been formulated for India:

Step 1. Training programs for managers, engineers and workers of steel plants.

It is recommended that the groups dealing with AFR in India and in the other developed countries be contacted and training programmes should be organized to improve the below mentioned skills of the new group of managers, engineers and workers in Indian steel plants:

a. To effectively identify, procure, and use the AFR in the steel plants in India;

b. To match the available waste to the fuel or raw materials to be replaced;

c. To do a market scan of the Indian waste spread and to identify waste in sufficient quantities to replace the fuel or raw materials;

d. To understand and replicate the equipment and processes for using the available waste in the steel making process, keeping in mind the constraints of the chemical composition of the raw materials available in the country. For this, contacts have to be developed with leading countries using these technologies;

e. To understand the economic viability of the use of AFR against the use of traditional fuel with additional investments in handling, storage, feeding and control systems;

f. To understand the control process and the desired supply chain system to take care of the unreliability of supply both in quantity and quality of the waste, since it is a waste and not a product;

g. To understand the legal and financial limitations as the use of AFR sometimes may result in lower specific outputs of steel and may adversely affect the quality of steel too;

h. To understand the legal limitations of the country, since India has laws for disposal of waste in waste disposal units, cement and power plants but there are no laws for its disposal in steel plants. These new laws have to generated and legislated;

i. To understand the internal stakeholder apprehension concerning the development of steel plants, that AFR's use would adversely affect reliability and production; and

j. To upgrade knowledge about the use of AFRs in the government ministries and environment control departments, which issue, implement and enforce laws governing waste utilization in steel plants.

Step 2. Specialized skills for drivers handling hazardous waste. Private companies in India have been providing the requisite training to the drivers and helpers handling the vehicles carrying hazardous waste. The steel plants should take similar initiatives to provide required trainings to the people engaged in the process. The following plan should be put in place:

a. The Ministry of Labour and Employment, Ministry of Commerce and Industry and Ministry of Environment should issue guidelines and make it mandatory for all steel plants to provide such trainings to the drivers and helpers of vehicles carrying hazardous waste.

b. The Ministry of Environment should provide the avenue for arranging training for the trainers programme for the steel plants.

c. To ensure the implementation of these directions issued by the ministries, the plants should be asked by the Ministry of Labour and Employment, Ministry of Commerce and Industry and Ministry of Environment to keep a record of the trainings imparted to the drivers and helpers of the vehicles carrying hazardous waste. Inspection of these records should be made a part of the audit process of the factory.

Recommended actions to be taken for the implementation of the Cluster C progressive green technologies. There are technologies which are in the developmental stage and which can, when commercialized, help to reduce GHG emissions. The study indicates that to ensure the best use of such technologies in the years to come, it would require the initiation of a plan to prepare for an adequate workforce with the right education, communication skills and other technical skills for catering to the operations and maintenance of the steel plants with these new technologies in place. In the following subsections, the study recommends actions to be undertaken by the government and industry to ensure adequacy of skills and knowledge in the sector for acceptance and implementation of Cluster C technologies once it gets commercialised.

a) Skill knowledge and technology group. There is a recognized need to address the requirements of industry to improve access to the information and training for the Cluster C progressive environmentally sustainable technologies. The study indicates the need for a strategy to track the development of these technologies and dissipate the information among the steel plants. This has to be developed by the Indian Ministry of Industry in association with the Ministries of Science and Technology and the steel industry. This model would ensure that the steel plants are well aware of the development of the technologies and can plan their induction as well as train the trainers to ensure proper manpower availability when the technology is dovetailed into the plants. The availability of the requisite knowledge and skills exclusive to the technologies shall ensure a proper return on investment for adopting the same in the plants.

It is recommended to take the following steps for the formulation of a skills, knowledge and technology group:

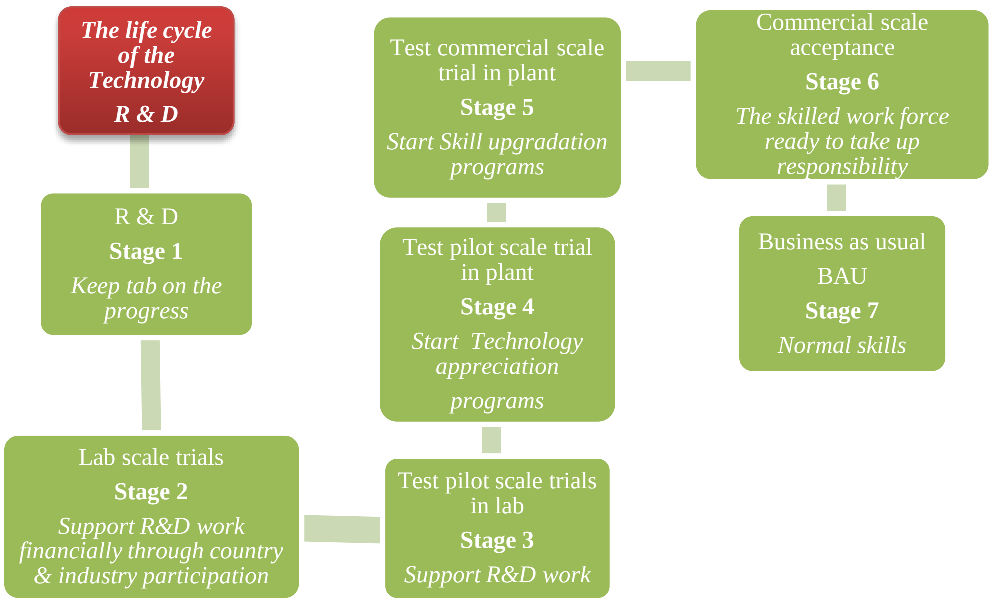
Step 1. A team of three people should be formed with one person each from the Indian public and private steel industry, Ministry of Commerce and Industry and Ministry of Labour and Employment, the Ministry of Science and Technology, with the Ministry of Science and Technology acting as the nodal point for implementation. This PPP model team will help to ensure country to country coordination for the proper transfer of SKT during development, deployment, diffusion, and transfer of Cluster C progressive green technologies for the Indian steel sector.

Step 2. This team should organize a meeting of the various R&D centres to explain the importance of the need to improve the access to information, knowledge and skills required for the green technologies of the future. In this meeting, two groups should be formed:

a. **A skill and knowledge management group**, which would track the development of the skills and knowledge for the adoption of the technologies into the plants. Their work would start when the technologies are tried out in the plant on a pilot scale. They may then keep track of the progress on the knowledge and skill and keep the plants updated on the same through leaflets/seminar/workshops and visits to the plants where pilot/commercial and final industrial scale trials are being undertaken. With this information, the plants can start the transfer of knowledge and skills well before the technologies are adopted, so that the same is available in the plants when it is dovetailed. This shall help to ensure that the technology gives the right amount of returns on investment and is not marred by lack of skill and knowledge.
b. **A technology management group**, which would track progress on the global scale of the various identified technologies and also identify the new technologies on the horizon.

This group would also keep the steel plants updated on the progress through leaflets/seminars and workshops.

Figure 1. The life cycle of technology R&D



Source: Ministry of Steel, Government of India, 2011.

b) Transparency in the local R&D groups. It is recommended that the Ministry of Labour and Employment, Ministry of Human Resources and Development, Ministry of Commerce and Industry and the Ministry of Science and Technology take proactive steps for information sharing about the Cluster C progressive green technologies within the Indian steel industry if such a change is legally required.

c) Regular training of trainers in the country. It is recommended that the Ministry of Labour and Employment, Ministry of Human Resource and Development, Ministry of Commerce and Industry incorporate in their training systems some additional sections in order to upgrade the knowledge of the trainers in the VTIs, polytechnics and graduate colleges on the new skills required for Cluster D technologies which are still under development.

6.4 Indirect manpower

Indirect manpower is required in areas of procurement and transportation of the raw materials and fuel and the marketing and distribution of steel over long distances around the country. The study indicates that the total indirect manpower requirement over the life cycle of steel from its mining and procurement of raw materials till its use at the construction site is expected to reach 2.6 million workers by 2020 in India. At present, the indirect manpower in the unorganized sector is trained either on the job training or by private training institutes. The following steps should be taken to provide an enabling environment for training of indirect skilled manpower of truck drivers, riggers and construction workers:

Step 1. Providing opportunities for the private motor vehicle training institutes to flourish to provide trained drivers for the indirect manpower requirement for handling the increased amount of steel. The study uncovered that out of the 2.6 million indirect manpower projected to be required for handling the steel produced by 2020, 1.0 million shall be for drivers and their assistants for handling the trucks for transportation of steel and raw materials. These drivers and their assistants are trained on the job and at private motor training institutes. The present facilities will be inadequate to provide trainings to this large skilled workforce.

The study reveals that the development of these private institutes would be an important component of a skill development strategy in the coming decade. To meet this challenge, it is recommended that the following actions be taken:

a. Specific courses should be introduced in the vocational training institutes to train the driver trainers, and to enable them to become small time entrepreneurs to start new motor training institutes.
b. Specific subsidized microfinance schemes should be initiated by the banks to support these trained entrepreneurs in their endeavours.
c. The motor vehicle driving licensing system should be enhanced and made stricter to ensure safe and efficient driving skills in the drivers and their assistants.

Step 2. Providing opportunities for the government and private institutes to provide trained crane operators, heavy equipment operators, riggers and rigger assistants for the indirect manpower requirement for handling the increased steel in the market. The study uncovered that of the 2.6 million indirect manpower for handling the steel produced by 2020, 0.3 million would be crane operators, heavy equipment operators (HEOs), riggers and their assistants for handling the steel at various places during its journey from the plant to the site of use. At present, there are no proper courses for the crane operators, HEOs, riggers and their assistants for handling steel and other materials. Currently, workers develop their skills mainly through hands on training and from their seniors on site. There are no training courses available for this category of workers, neither by public nor by private sector vocational training institutes. The present system of using the hands on experience method is very slow in generating trained and skilled hands in the market. It will be unable to meet the demand expansion with respect to the increase in production and demand of steel. Consequently, it will create an unsafe situation by bringing in untrained workers to handle the increased production.

The study revealed that the development of the crane operators, HEOs, rigger and rigger assistant skilled category in the VTI, both private and government, would be an important component of the skills development strategy in the coming decade. To meet this challenge, it is recommended that the following actions be taken:

a. Specific courses for crane operators, HEOs, riggers and rigger assistants should be introduced in the vocational training institutes to train them to operate as small time entrepreneurs by starting private crane operator, HEO and rigger training institutes.
b. Specific subsidized microfinance schemes should be initiated by the banks to support these trained crane operators, HEOs, and rigger entrepreneurs in their endeavours to start training institutes.

Step 3. Providing opportunities for the government and private training institutes to provide trained multi-tasking construction workers for the indirect manpower

requirement for handling the increased amount of steel. Of the estimated 2.6 million indirect workers required by 2020, 0.5 million shall be multi-tasking construction workers. The training for workers capable of doing the work of steel bar bending, shuttering etc. requires them to be inducted in the government and private sponsored VTI. However, the present facilities will not be adequate enough to provide the required number of workers in the coming decade since there is a lack of training curriculums for multi-tasking construction workers in the VTI.

The development of a curriculum for the multi-tasking construction workers both in the private and government VTI would be an important component of the skills development strategy in the coming decade. To meet this challenge, it is recommended that the following actions be taken:

a. Specific course curriculum should be developed and started in the vocational institutes to train multi-tasking construction workers.
b. Special trainings should be organized for the trainers of these courses, to ensure adequate and effective training can be provided to the jobseekers being trained in such courses.

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Annexes

Annex I. Case study: Tata Steel India

Tata Steel India, Jamshedpur, India

Backed by 100 glorious years of experience in steel making, Tata Steel, with a global presence in 50 developed European and Asian countries has manufacturing facilities in 26 countries and has an existing annual crude steel production capacity of 30 MTPA. Established in 1907, it developed the first integrated steel plant in Asia and is now the world's second most geographically diversified steel producer as well as being a Fortune 500 company. Their vision is to be a global steel industry benchmark for value creation and corporate citizenship. The 2012 goal places equal emphasis on economic performance and corporate citizenship through social and environmental performance, thus truly integrating sustainability concepts into the ethos and aims of the Tata Steel Group. Tata Steel has always adopted effective measures in improving its processes, invested in break-through technology like ULCOS (ultra-low CO_2 steel making). In addition, the operations have achieved the ISO-14001 certification for environment management.

One of the main goals of Tata Steel is to reduce CO_2 emissions to less than 1.7 tonnes per tonne of liquid steel (t/tls). Tata Steel's management approach to sustainability is to integrate consideration of the 'triple bottom line' – economic, environmental and social performance - into the company's thinking and business practices. At Tata Steel the purpose of the organization is to go 'beyond business', to invest and develop for the benefit of society. This is achieved through the principles of corporate citizenship and inclusive growth.

Capacity

Tata Steel India's present capacity is 6.56 MTPA. TSI invested INR11,500 Crore from 2010-12 to add 3 MTPA capacity of crude steel and reached 9.56 MTPA in 2012. The company has proposed three green field steel projects in the states of Jharkhand, Orissa and Chhattisgarh with an additional capacity of 23 MTPA.[13]

Energy and fuel conservation

It has been well understood at TSI that in these competitive times energy conservation is important and that growth can only be achieved through the adoption of new and efficient technology, modernization of equipment and new ways of operating.

TSI has focused on the following technologies:[14]

- TRT: Installation of top pressure recovery turbines at 'G' and 'H' blast furnaces;
- CDQ: Recovery of sensible heat of coke by installation of a coke dry quenching system in batteries 5, 6 and 7 at the coke plant;
- WHRS: Enhancement of waste heat recovery at sinter plants;

[13] Business Policy & Strategic Management group of SDM Institute of Management Development, *Interim report on TATA Steel*, New Delhi, 2011.
[14] Tata Steel, www.tatasteel.com [accessed 19 Nov. 2013].

- Natural gas: Installed a BF gas fired re-heating furnace at the Hot Strip Mill;
- Improvement in LD gas recovery;
- Conversion of all four coal-fired boilers no. 7 and 8 at Power House-3 to facilitate by-product gas firing;
- Installation of variable frequency drives at the LD Shop and Hot Strip Mills; and
- Measures for reducing electrical power consumption.

These measures were completed by 2007–08. See table A1 for productivity parameters achieved.

In addition, Tata Steel India also reduced GHG emissions by 2.4 per cent in 2007–08.

Table A1. Productivity parameters of Tata Steel India by implementing some of the Cluster 1 technologies

	Productivity parameters	**Productivity values**		
		1996–97	2008–09	% improvement
1	Specific energy consumption GCals/tcs	8.72	6.59	32.28
2	Specific water consumption including power plant M^3/tcs	11.84	6.80	42.57
3	Specific water consumption excluding power plant M^3/tcs	8.98	4.72	47.44
4	Specific raw material Consumption t/tcs	4.45	3.00	32.58
5	Carbon dioxide emission tCO_2/tcs	3.19	2.09	34.48
6	Water pollutant discharge kg/tcs	0.40	0.13	67.50
7	Solid waste utilization per cent	57.00	89.61[15]	57.21
8	Stack emission – SPN kg/tcs	3.50	0.83	76.29
9	Boiler coal consumption kg/tcs	N/A	38.97	-
10	LD gas recovery NM^3/tcs	N/A	66.80	-
11	Combine boiler efficiency per cent	N/A	83.67	-

Source: Tata Steel.

Raw materials

Tata Steel India has made great strides in its effort to reduce the use of natural resources per tonne of steel manufactured by it. The company has reduced raw material consumption from a level of [3]5 t/tcs to nearly 3 t/tcs in the last 12 years.

[15] Of the 659 kgs/tcs of various kinds of waste (excluding fly ash) generated.

Emissions, effluents and waste management

Reducing GHG emissions is a priority for the company. Operational investments, such as the new H blast furnace in Jamshedpur, seek to employ state-of-the-art equipment, which improves efficiency and reduces pollution.

GHG emissions

Of the six greenhouse gases, carbon dioxide is most relevant for the steel industry. Tata Steel has reduced CO_2 emission by 35 per cent in the last 12 years. Following specific measures to address greenhouse gas emissions, there is a steady downward trend in CO_2 emissions from the steel works. In 2007-08, CO_2 emissions were reduced by 4.2 per cent to 2.04t/tcs, equating to 2 t/tls. CO_2 emission calculations are based on GHG protocol guidelines.

Solid waste management

Tata Steel generates around 659 kg of various kinds of solid wastes (excluding fly ash) for every 1 tonne of crude steel produced.[16] About 85 per cent of these wastes are utilized either through recycling and reuse in their own processes or sold as input materials to other industries. The remaining wastes are sent to land fill.

Plant and processes

Tata Steel has always believed in adopting an innovative approach in its processes and product development to ensure the best use of available technology in its operations. Energy conservation and efficiency improvement measures are continuously developed and implemented at Tata Steel's plants in an effort to meet environmental challenges effectively.

Initiatives undertaken for GHG emission reductions

- Conversion of coal-fired boiler no. 7 and 8 at Power-house-3 to by-product gas firing. All four boilers at this powerhouse now have by-product gas firing;
- Installation of variable frequency drives at the LD Shop and Hot Strip Mills;
- Measures for reducing electrical power consumption;
- Installation of top recovery turbines at ‘G' and ‘H' blast furnaces;
- Recovery of sensible heat of coke by installation of coke dry quenching system in Batteries 5, 6 and 7 at coke plant;
- The enhancement of waste heat recovery at sinter plants;
- BF gas fired re-heating furnace at the Hot Strip Mill;
- Improvement in LD gas recovery;

[16] Tata Steel, www.tatasteel.com, [accessed 19 Nov. 2013].

- Installation of coal tar and waste oil injection in the blast furnaces;
- Improved process efficiency through the automation of all major plants;
- Strengthening the various non-fuel gases distribution like oxygen, nitrogen, compressed air and steam;
- Switching over from open ladle to torpedo ladle for hot metal transportation;
- Installation of thermo compressors to utilize waste steam to convert it to low pressure steam at coke plant; and
- Replacement of old motors and other power driven equipment with energy efficient motors.

Positive results of initiatives for energy efficiency (2007–08)

- Lowest ever plant specific energy consumption of 6.655 tcs/tcs;
- Lowest ever boiler coal consumption of 38.97 kg/tcs;
- Higher LD gas recovery of 66.80 Nm3/tcs; and
- Higher combine boiler efficiency of 83.67 per cent.

Environment management

Tata Steel has initiated a number of activities at various levels and locations to address climate change issues:

- Tata Steel recently launched its Vision 2012 that emphasizes the reduction of CO_2 emissions (to the level of 1.5 t/tls).
- Tata Steel India has set itself a goal to reduce its CO_2 footprint by at least 20 per cent by year 2020 compared to 1990.
- The Tata Steel Group is also, through projects such as the ultra-low CO_2 steelmaking project (ULCOS), engaged in cutting edge research to develop new technologies for the long-term future of the industry, which will break through existing technological barriers, to achieve a 50 per cent reduction in carbon emissions by 2050.
- To improve its processes, priority is given to energy conservation schemes; in technology breakthroughs such as ULCOS making and in other innovative projects where the group has proprietary technology.
- A strategy has been formulated by Tata Steel India to reduce GHG gases that highlights the following points:
    1. Continuing to improve current processes and benchmarking to be the best within the steel industry;
    2. Usage of renewable energy resources;
    3. Adoption of energy efficient technologies for all future expansion plans;
    4. Investing in breakthrough technologies;
    5. Developing new products and services to reduce environmental impacts over the product

lifecycle;

6. Creating awareness at all levels and functions; and
7. The Tata Steel Works at Jamshedpur has reduced CO_2 emissions by 36 per cent in the last 12 years. This has been made possible by:
   a. Phasing out of old and inefficient facilities;
   b. Adoption of modern energy efficient equipment and processes;
   c. Improving the by-product fuel recovery and usage; and
   d. Waste heat recovery, etc.

Technology

Waste utilization and energy conservation

A significant step forward in technology development from the environmental perspective was the commissioning of a Fluidized Bed Combustion Power Plant in 1988 to use washer waste to generate green power. This 10 MW plant made the Jharia Division self-sufficient in power even in exigencies.

The fly ash generated by the power plant is in turn used to reclaim mined out areas and preserve the health of the land. Tata Steel has undertaken several initiatives in reducing stack emissions considerably and keeping it well below the Indian and international standards. All hazardous wastes generated at Tata Steel facilities are handled as per the requirement of the Hazardous Waste Management and Handling Rules of 1989/2000.

Manpower

Tata Steel has shifted its focus from reducing manpower just in terms of numbers, to bringing down the cost of the manpower itself. They are currently operating at 18 to 20 per cent of the gross turnover, which they want to reduce to 10 per cent.

Tata steel India reduced manpower from around 79,000 in 1996 to 34,260 in 2009. Tata Steel is also adopting methods other than the Early Retirement Scheme (ESS). Out sourcing and joint venture companies to take over non-core work has been adopted. Tata Steel has, however, declared its intention of keeping a controlling 51 per cent stake in all these joint ventures.

Training

Tata Steel India has taken steps to improve the technical education in and around the areas they operate in:

- Tata Steel India in a PPP has initiated an initiative to provide skilled manpower for its plant and other manufacturers. Tata Steel India, State Bank of India, Orissa State Government and the CAP Foundation have joined hands to produce skilled manpower for the industry and the market with occupation and technology-based skills training programmes.[17]

- Tata Steel India also provides the scheduled tribes a two-year certificate programme. This is being done with the Scheduled Caste and Scheduled Tribe Development Finance Corporation and the Employment Mission of Orissa government. This relates to the occupation-based civil, electrical and mechanical jobs.
- In another PPP, Tata Refractories Limited (TRL) has partnered with the State Bank of India to set up the Self Employment Skill Development Institute (SESDI) at Belpahar in Orissa. This institute was started in April 2009 and provides market related occupation-based skills training in trades as welding, electrical engineering, wiring, and plumbing, etc. The self-employed technicians from around the institute provide the faculty.
- In association with the Hyderabad-based CAP Foundation, Tata Steel has started vocational training programmes for the rural youths at Keonjhar and Jajpur districts of Orissa. This initiative has the capacity for 1500 girls and boys per year. It provides an employability and entrepreneurship programme and offers training courses on customer relations and sales, information technology (IT) enabled services, hospitality, mobile and white goods repairing, electrical and automobiles free of cost. After completion of the course, the pass-outs have been successfully absorbed by Magma Finance Limited, Tata Indicom, Dousoft, ICICI Prudential, max New York life, TVS, Big Bazaar and Reliance.
- In April, 2005 Tata Steel launched the J N Tata Technical Education Centre (JNTTEC) in Gopalpur, which was established with an investment of INR28 Crore, and has successfully produced skilled manpower in macaronic, electronics and manufacturing technology. In the last three years, students passing out from JNTTEC have received 100 per cent placements in leading corporate houses such as Siemens, Maruti Suzuki, and Al-Shirwai.

Conclusions

The study found that this plant of Tata Steel India has been implementing plans for dovetailing Cluster 1 technologies since the last decade. These technologies helped them to reduce their GHG emissions and their CO_2 footprint. The implementation of these technologies has also demonstrated a very good business case. Tata Steel India is the world's lowest cost producer of steel. The study also found many PPP initiatives for setting up training facilities around their place of operations to improve the general skills of the community workforce. These initiatives can be studied and reproduced in and around the other steel plants too.

The list of projects, which are at various stages of implementation to reduce CO_2 emission include:

1. Reduction of coke rate by improving the per cent of prepared burden and high top pressure;
2. Installation of 120 MW by product gas-based captive power plant (Power House No. 6 under Joint Venture);
3. Reduction of the carbon rate in blast furnaces by improving raw material quality;

[17] Patnaik, N.: "Tata Steel, SBI join hands to produce skilled manpower", in *The Economic Times* (India), 15 July 2010. Available at: http://articles.economictimes.indiatimes.com/2010-07-15/news/28492583_1_skilled-manpower-orissa-government-tata-steel [accessed 15 May 2012].

4. Waste heat recovery from waste gases from hot stoves in H blast furnace;
5. Installation of an op gas pressure recovery turbine in the H blast furnace;
6. Installation of the pulverized coal injection facility in the H blast furnace;
7. Installation of energy efficient blowers (electric motor driven) from delivery of cold blast in H blast furnace;
8. Recovery and utilization of LD Gas from LD3;
9. Installation of variable frequency drives at sinter plants;
10. Installation of variable frequency drives in H blast furnace, LD shops, mills, and power houses;
11. Replacement of open top ladles with torpedo ladles and balancing facilities;
12. Installation of 3rd reheating furnace in hot strip mill based on B.F. Gas;
13. Improvement of productivity/efficiency at sinter plant No. 1(bed height increase);
14. Replacement of vapour compression machine with vapour absorption machine in plant;
15. Energy optimized sintering at sinter plant No. 3 and 4;
16. Coke Dry Quenching (CDQ) for coke oven battery No. 8,9,10 and 11;
17. Waste heat recovery from sinter coolers of sinter plant Nos. 3 and 4;
18. Top gas recovery turbine in C and F blast furnaces;
19. Waste heat recovery from ammonia incinerators;
20. VFD for waste gas fan motors in sinter plant No. 2;
21. Energy efficient blowers for A-F blast furnaces; and
22. Replacement of existing exhausters and boosters with energy efficient equipment at coke plant.

Annex II. Capacity estimates and investments of integrated steel plants in India

Table A2. Capacity estimates and investments for integrated steel plants in India

Company	Capacity 2008–09 MTPA	Capacity 2011–12 MTPA	Capacity 2019–20 MTPA	Estimated investment INR Crore
SAIL	12.84	24.84	60.00	*78 845
RINL	2.90	6.30	6.30	8 962
NMDC	Nil	Nil	3.00	16 000
TISCO	5.00	13.00	33.50	87 900
ESSAR	4.60	14.50	20.50	68 000
JSW	4.10	11.00	31.00	111 700
JSPL	1.20	10.50	26.50	89 387
ISPAT IND	3.00	5.00	17.00	30 400
Total	**33.64**	**85.14**	**197.80**	**491 194**

* SAIL Estimates are till 2011–12 only

Source: Ministry of Steel, Government of India, 2011.

Annex III. Details of production and steel producers in India

Table A3. Production of main and secondary producers of steel

No.	Item/Producer/Production	2005–06	2006–07	2007–08	2008–09	Apr.–Dec. 2009
I	Crude steel					
	Main producers	21 402	21 868	21 789	21 755	17 122
	ASP + VISL	292	309	315	263	228
	Other producers					
	EAF Units (incl. COREX and MBF/EOF)	11 273	13 250	14 820	18 365	13 529
	Induction furnaces	13 493	15 390	16 933	18 054	14 896
	Total (crude steel)	46 460	50 817	53 857	58 437	45 775
	Percent share of other producer	53.3	56.4	59.0	62.3	62.1
II	Pig Iron					
	Main producers	1 007	860	936	589	585
	Other producers	3 688	4 133	4 378	5 618	3 673
	Total (Pig Iron)	4 695	4 993	5 314	6 207	4 248
	Percentage share of other producers	78.6	82.8	82.4	90.5	86.5
III	Sponge iron					
	Gas based	4 545	5 265	5 845	5 516	4 560
	Coal based	10 280	13 080	14 531	15 575	10 928
	Total (sponge iron)	14 825	18 345	20 376	21 091	15 488
	Percentage share by process (Coal based)	69.3	71.3	71.3	73.8	70.6
IV	Finished steel for sale (alloy/non alloy)					
	Main producers	16 413	17 614	18 020	17 216	12 887
	Other producers	34 809	40 047	43 332	46 229	3 5224
	Lass IPT/own consumption	4 656	5 132	56 075	57 164	43 849
	Total (finished steel)	46 566	52 529	56 075	57 164	43 849
	Percentage share of other producers	74.8	76.2	77.3	80.9	80.3

* Provisional; Annual report 2009–10 of the Ministry of Steel, GOI.

Source: Ministry of Steel, Government of India, 2011.

Annex IV. Calculations of indirect man-hours per tonne for steel

Assuming the steel product is to be sent to the market and it goes directly to the dealer and gets sold to the user. The track shall be as follows with the estimated man-days required at each stage:

1. Loading of 20 tonnes on the truck 4 persons for 4 hrs — 2.0 man-days
   (This takes care of the loading at various places before it reached the dealer for final sale)
2. 4 days travel till it reached the dealer 2 persons for 4 days — 8.0 man-days
   (This takes care of the intermediate travel before it reaches the dealer for final sale)
3. Unloading at dealer and other intermediate places 4 persons for 4 hrs — 2.0 man-days
   (This takes care of the unloading at various places before it reaches the dealer for final sale)
4. Storage and other handling 1 person for six days — 6.0 man-days
   (This takes care of the storage and handling at various places including that of the dealer for final sale)
5. Truck driver and cleaner for delivery to site for 2 hrs — 0.5 man days
6. Unloading at usage point 6 persons for 2 hrs (manual) — 1.5 man-days
7. Usage of steel @ one tonne per day — 20.0 man-days
8. Total man-days for 20 tonnes — 40.0 man-days
9. Man-days per tonne of steel delivered and used — 2.0man-days

Similar man-days are used up for all the raw materials used for producing steel. The requirement is almost 1 tonne of raw materials and stores per tonne of steel produced other than the captive mined iron ore, etc.

Thus for each tonne of raw material and stores and spares handling per tonne of steel produced and used will require: 2.0 man-days.

This for each tonne of steel produced indirect labor required is 2 + 2 = 4.0 man-days

At 8 hrs per day this would be 32 man-hours per tonne of steel produced 32.0 man-hrs/t-steel

Skilled category requirement is for the following:

1. Crane operator to handle steel
   a. At stage 1 — 4 man-hrs
   b. At stage 3 — 4 man-hrs
   c. Total man-days per 20 tonnes steel — 1 man-day

2. Heavy equipment operator for raw materials
   (Same as that for a crane operator) per 20 tonne steel — 1 man-day

3. Truck drivers for steel and raw materials
   a. At stage 2 (4 x 2) — 8 man-days
   b. At stage 5 (1 x 2) — 2 man-hrs
   c. Total for 20 tonnes of steel — 8.25 man-days

Annex V. Major integrated steel plant level performances in India

Table A4. Major integrated steel plant level performance in India

Plant	Production MTPA	Process route	Specific energy consumption GJ/tcs	Specific energy consumption (SEC) with BATGJ/tcs	Deviation from BAT per cent	Specific CO_2 emissions (SCE) MT CO_2/tcs
SAIL Bhilai	5.06	BH-BOF/THF	28.1	16.7	68	2.82
SAIL Durgapur	1.91	BF-BOF	29.0	16.7	74	2.74
SAIL Rourkela	2.09	BF-BOF	30.9	16.7	85	3.16
SAIL Bokaro	4.13	BF-BOF	28.8	16.7	72	3.03
SAIL Burnpur	0.46	BF-THF	34.0	16.7	104	5.50
RINL Vishakapatnam	313	BF-BOF	27.3	16.7	63	3.18
TATA Steel Jamshedpur	5.01	BF-BOF	27.8	16.7	66	2.04
JSW Bellary	3.62	COREX/BF-BOF	28.9	18.0	59	2.50
Essar Hazira	3.37	Gas HBI-EAF	25.0	15.6	60	1.55
ISPAT Dolvi	2.74	Gas DRI/BF-EAF	21.9	16.2	35	2.45
JSPL Raigarh	2.16	Coal DRI/BF-EAF	23.4	17.7	32	NA
Tata Sponge	0.39	Coal-DRI	25.0	14.0	79	2.10

Source: Green Rating Project 2009, Centre for science and environment, New Delhi, 2010.

Annex VI. New green sectors in India

The main new sectors emerging as the result of greening economy in India are environmental services, renewable energy and industrial waste utilization.

Table A5. The main new sectors emerging as the result of greening economy in India – environmental services

	Company scale		Location		Ownership		
Sector	Large	SMEs	Rural	Urban	National	Jt Venture	**New occupation**
Environmental services							
Environmental impact assessment	√	√	-	√	√	-	Environmental Officer
Recycle	√	√	-	√	√	√	Waste collector Recycle officer and engineer for large scale operation
ISO 1400 Consultant	√	√	-	√	√	√	Environmental Officer
Waste management	√	√	√	√	√	√	Waste expert
Environmental lab	√	√	√	√	√	√	Physicists / Biologist/ Engineer / Chemist
Environmental quality monitoring	√	√	-	√	√	√	Environmental expert
Maintenance	√	√	-	√	√	-	Environmental officer Instrument engineers Electricians
Environmental training and education	√	√	-	√	√	-	Educator, Psychologist, faculty with environment experience

Source: Ministry of Steel, Government of India, 2011.

Table A6. The main new sectors emerging as the result of greening economy in India – Renewable energy

Sector	Company scale		Location		Ownership		New occupation
	Large	SMEs	Rural	Urban	National	Jt Venture /MNC	
Renewable energy							
Geothermal	√	-	√	-	√	-	Geothermal engineer Electrician
Big hydro	√	-	√	-	√	-	Hydro engineer Electrician
Micro-hydro	-	√	√	-	√	-	Hydro engineer Electrician
Solar panel retailer	-	√	-	√	√	-	Electrician
Wind power	√	-	-	√	√	√	Wind power engineer
Biogas	√	√	√	√	√	-	Biogas engineer Electrician
Municipal waste	√	√	-	√	√	-	Waste engineer
Bio fuels	√	√	√	-	√	-	Bio fuel/waste engineer
Carbon consultants	√	√	-	√	√	√	Carbon accounting expert Financial analyst for carbon projects

Source: Ministry of Steel, Government of India, 2011.

Annex VI. (Continued)

Table A7. The main new sectors emerging as the result of greening economy in India – Industrial waste utilization

Sector	**Company scale**		**Location**		**Ownership**		**New occupation**
	Large	SMEs	Rural	Urban		Jt Venture /MNC	
Industrial waste utilization							
Water and liquid management	√	√	√	√	√	√	Waste expert
Hazardous and toxic waste management	√	√	√	√	√	√	Waste expert Safety expert Hazardous waste storage expert Processing expert Hazardous and toxic laboratory expert
Preprocessing platforms for all types of waste	√	√	√	√	√	√	Waste engineers Compatibility experts AFR laboratory experts and operators Plant O and M staff Waste Mapping and procurement experts Contracting experts Waste and preprocessed transportation experts
Noise management	√	√	√	√	√	√	Noise expert and monitoring officer
Air pollution management	√	√	-	√	√	√	Air quality expert and monitoring officer
ISO 14000 certification bodies	√	√	-	√	√	√	ISO 14000 expert

Source: Ministry of Steel, Government of India, 2011.

Annex VII. List of the training institutes for the steel industry in India

1. Steel Authority of India Limited (SAIL) has three central units:
    a. Research and Development Centre for Iron and Steel (RDCIS);
    b. Centre for Engineering and Technology (CET); and
    c. Management Training Institute (MTI) all located at Ranchi.

2. Biju Patnaik National Steel Institute (BPNSI):
    a. The BPNSI was established to help the domestic secondary steel industry to keep up with the rapid transformation, which the global and Indian steel industries, have been undergoing.

3. National Institute of Secondary Steel Technology (NISST):
    a. The need for human resource development and technology upgrading in the secondary steel sector comprising mainly the steel melting units with Electric Arc Furnace (EAF) or Induction Furnaces (IF), and the re-rolling units has been felt for a long time. The Advisory Committee expressed a similar opinion on steel rolling industries, set up by the Ministry of Steel, Government of India in 1984. It was primarily based on these needs and also the demands from industry, that the National Institute of Secondary Steel Technology was set up as a registered society on 18th August, 1987 under the Chairmanship of the then Development Commissioner for Iron and Steel and presently Joint Secretary, Ministry of Steel, with the following aims and objectives:
        i. To provide trained technical manpower to the secondary steel sector through short-term and long-term courses and to update their knowledge base;
        ii. To bring awareness about the state of the art technology by holding seminars, workshops, and symposiums;
        iii. To provide various industrial services and testing facilities;
        iv. To extend consultancy services to industries in terms of solving technological problems, improving energy efficiency and reducing pollution levels;
        v. To conduct research, development and design work in frontier areas for providing updated technology to this sector;
        vi. To organize for documentation and information retrieval services to the industry; and
        vii. To provide a platform for interaction between industry and educational as well as research institutions.
    b. The following areas of secondary steel sector are under the purview of the institute:
        i. Electric arc and induction furnace;
        ii. Ladle refining;
        iii. Rolling mills (hot and cold); and
        iv. Direct reduced iron units.

4. Institute for Steel Development and Growth (INSDAG):
    a. The initiatives for setting up the INSDAG emanated from the steel producers and the

institute was registered as a Society on 26 August 1996. The mission of the institute is to work in unison with all stakeholders in the steel industry so as to evolve ways and means for efficient usage of steel and provide optimum value to the customers. The institute primarily works towards the development of technology in steel usage and build market for the steel fraternity.

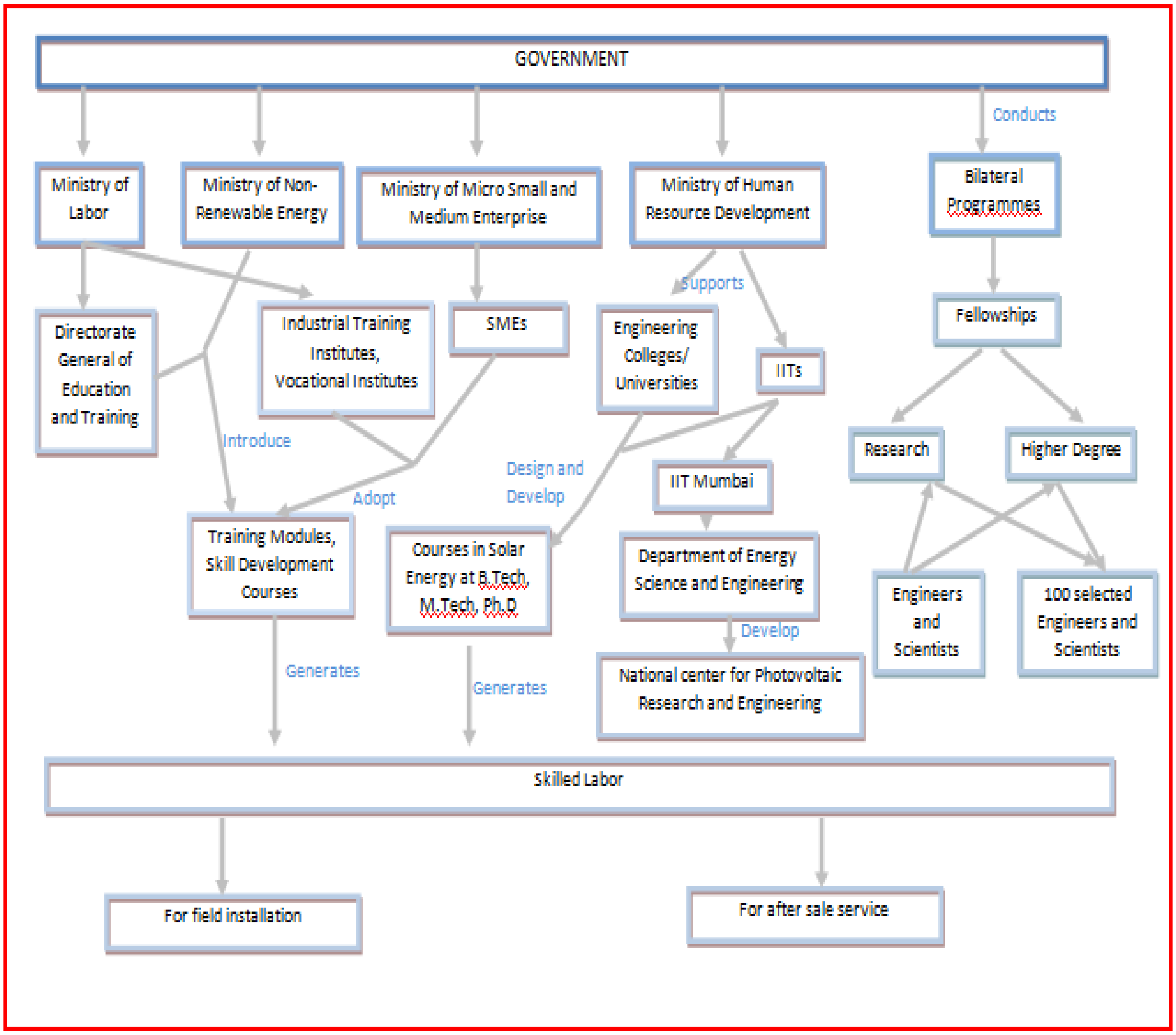
b. Education/Training of Professionals and Teaching Faculty on Steel Design: For enhancing the knowledge and skill of faculty and professionals in the country on structural steel design methods and technologies, several refresher courses and short term training programs were conducted. INSDAG also took several consultancy assignments from government agencies to showcase steel intensive structures usefulness and cost effectiveness in large commercial/ office complexes, multistoried car parks, bridges etc.
c. INSDAG is continuously engaged in various seminars, conferences, training and knowledge dissemination programmes all across the country. Architects, design engineers and planners have been educated in the innovative uses of steel in modern structures and constructions. INSDAG is regularly engaged in publication of various designs and updating of current designs in structural engineering. INSDAG has contributed significantly for design and manufacture of steel bullock carts, which has helped the rural and agricultural sector. Efforts to promote various innovative uses of steel are being continuously taken up by INSDAG.

5. Shavak Nanavati Technical Institute (SNTI), Jamshedpur
   This institute is run by the Tata Steel and provides technical skills training for secondary school apprentices, training them for the requirements of the TATA Steel and others.

6. Tata Management Training Centre (TMTC), Jamshedpur and Pune
   It provides training to the Top and Middle Management staff.

Annex VIII. Training organization of the Government of India

Figure A1. Training organization of the Government of India



Source: Ministry of Human Resource Development, Government of India, 2011.

Skills trends for green jobs in the steel industry in India

This report reviews the skills available and skills required for the introduction and deployment of green technologies in the steel industry in India. It reviews the existing systems in place for developing a skilled labour force and proposes some specific recommendations on how to adapt to evolving demands. The report provides evidence and new information to contribute to a well-informed tripartite dialogue on promoting access to skills for green jobs and the greening of existing jobs in the Indian steel sector to create decent, productive work and to improve the competitiveness and environmental sustainability of the industry.

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green jobs

DECENT WORK
A better world starts here.

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